KAHN SYSTEM of REINFORCED CONCRETE

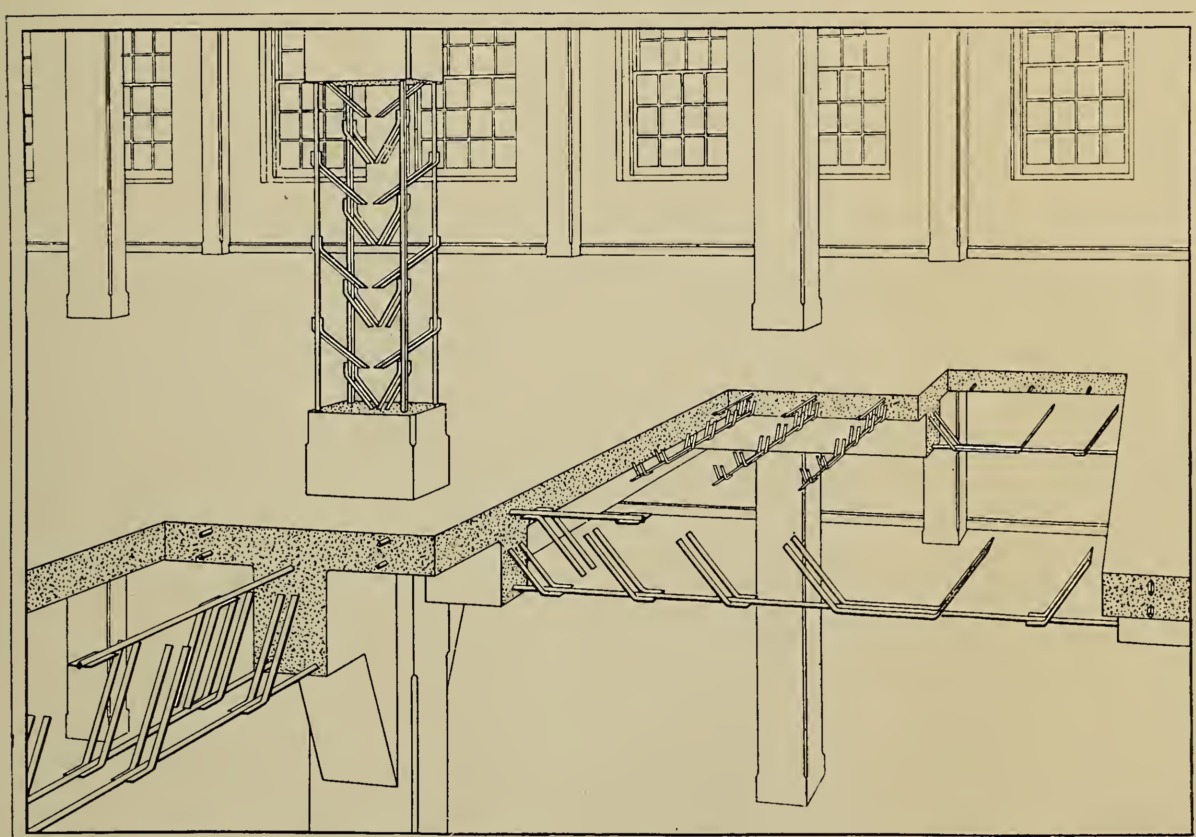
PATENTED

General Catalogue D

The Trussed Concrete-Steel Co.
Union Trust Bldg. Detroit.

Truscon steel company

Kahn System of Reinforced Concrete



Perspective of general adaptation.

[redacted]

Trussed Concrete Steel Co.,
Union Trust Building
Detroit, = Michigan.

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STEEL WORKS AT DETROIT AND PITTSBURG.
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The Kahn Trussed Bar.

Note.—This handbook is revised in accordance with the most recent practice of the Trussed Concrete Steel Co., and should be given preference to all previous issues.

Reinforced Concrete Bridge designed in accordance with "Kahn System" of Reinforced Concrete.

Kahn System of Reinforced Concrete

So much actual work is being done at the present time with reinforced concrete, and in general, the subject is receiving such intense interest by those taking part in buildings, bridges, or other constructions, that the new method of steel reinforcement herein described, it is believed, will be of interest.

The advantages of reinforced concrete above steel, masonry, or wood, are so well known, that it is hardly necessary to enter into comparison here. Reinforced concrete is absolutely free of any of the serious objections which exist in the use of these other materials. It is fire proof, and rust proof, but what is most advantageous about this type of construction, is the fact that its strength continually increases with age.

Reinforced concrete lends itself admirably to the construction of walls, columns, floors, roofs, and all parts of buildings; to bridges, arches, culverts, abutments, retaining walls, tunnels, foundations, railway ties, and in general, it replaces, to advantage, all masonry or steel construction.

The Kahn trussed bar consists of a half truss, struck up directly from a single rolled section, and provides the tensional members only. Concrete within itself is an excellent material to take up compressive strains, but is comparatively weak for resisting tensile strains. The Kahn bar, when imbedded in a mass of concrete, therefore, supplies strength to the latter where this is

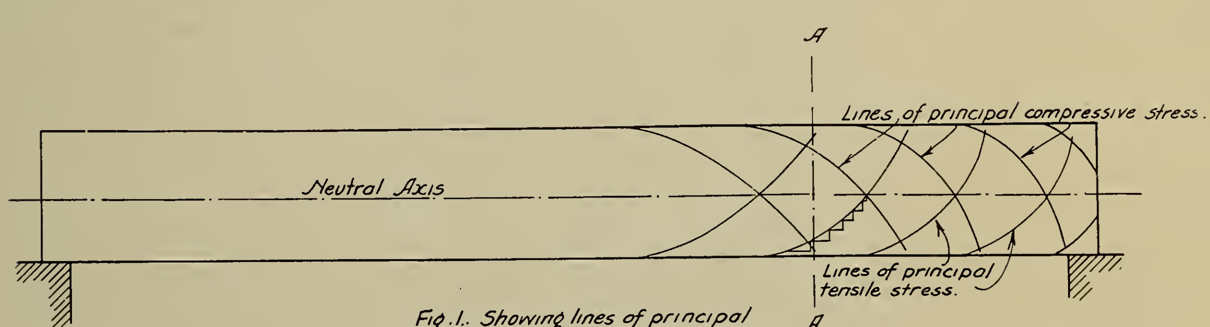


Fig. I. Showing lines of principal stress in a uniformly loaded beam supported at ends.

most necessary, and the combination of the two materials, forms a complete truss. The main virtue of this trussed bar lies in the fact that concrete is reinforced wherever it is deemed necessary, that the steel extends upwardly into the mass, as well as lying merely along its bottom edge. This, then, in short, is the essence of this new type of construction, and a further reading of this pamphlet will show the large number of its applications.

It is fairly well recognized among engineers, that vertical reinforcement for concrete beams is just as essential as the horizontal reinforcement, and in many cases to accomplish this purpose, the horizontal rods are surrounded by U shaped stirrups of band or twisted iron. It was noticed at first by European engineers that a concrete beam, when tested to destruction under uniform loading, invariably failed by shear at the ends, the lines of rupture corresponding closely to the lines of principal compressive stress for such a beam, as is shown in Figure 1. In this country engineers were apparently very slow to

realize the importance of such vertical reinforcement. In fact, upon its strong recommendation by one of the U. S. Engineer Corps in a leading Engineering Journal, a number of engineers argued the matter strongly and pointed out tests which they had actually made, where apparently the break did not occur at the ends of the beam. Without one exception, however, these tests, when investigated, proved to be beams which had been loaded either unfairly, so as not to develop strains actually occurring in building practice, or they referred to beams so abnormally proportioned that they could not possibly be used.

The Trussed Concrete Steel Company has made a number of tests on beams reinforced with plain and deformed rods on the bottom, and without one exception, all such beams, when tested to destruction under uniform loading, failed suddenly by vertical cracking or shear through the concrete, or longitudinal shear along the end of the rod.

This matter of vertical reinforcement is certainly of more importance than some American Engineers have been willing to grant. It seems most natural

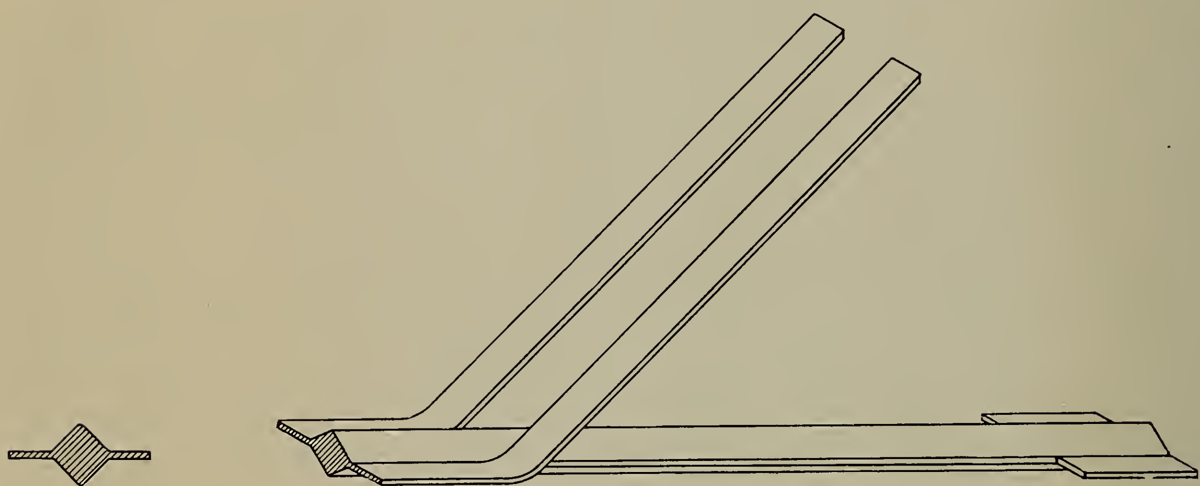


Fig. 2.

that rupture should occur in this manner. In fact, one can hardly conceive of its occurring in any other way. It must, of course, be remembered that a beam, when tested for both shear and bending moment, should be subjected to a uniformly distributed load, not to a concentrated center load; for, a beam loaded according to this latter method would only develop one-half the shear which exists in a uniformly loaded beam for a given bending moment.

Take, for example, a certain beam, as shown in Figure 1, and consider the cross section "AA."

The tension strain on each fibre below the neutral axis, varies in proportion to its distance therefrom. The vertical shearing is, however, practically constant. The resultant strain on any particle should therefore be a combination of these two components, producing a line of principal tensile stress, which is one of variable curvature from the bottom of the beam to the top.

If, then, lines of principal tensile stress exist throughout a beam, it is most natural that the concrete, being weak in tension, should open at right angles to these lines, and this is what has occurred in all the tests which the writer has observed in well proportioned concrete steel beams, when tested to destruction under uniform load, and where the metal reinforcement was horizontal only.

As has already been noted, European engineers endeavored to overcome the difficulty by placing stirrups throughout the beam, their distances apart varying, of course, in the inverse ratio of the shear. There seems no doubt whatever in the writer's mind that such stirrups accomplish a great deal of good, as they cross the lines of rupture at an angle, and tend to hold the material together. If, however, they are placed in a beam, they should be placed in a

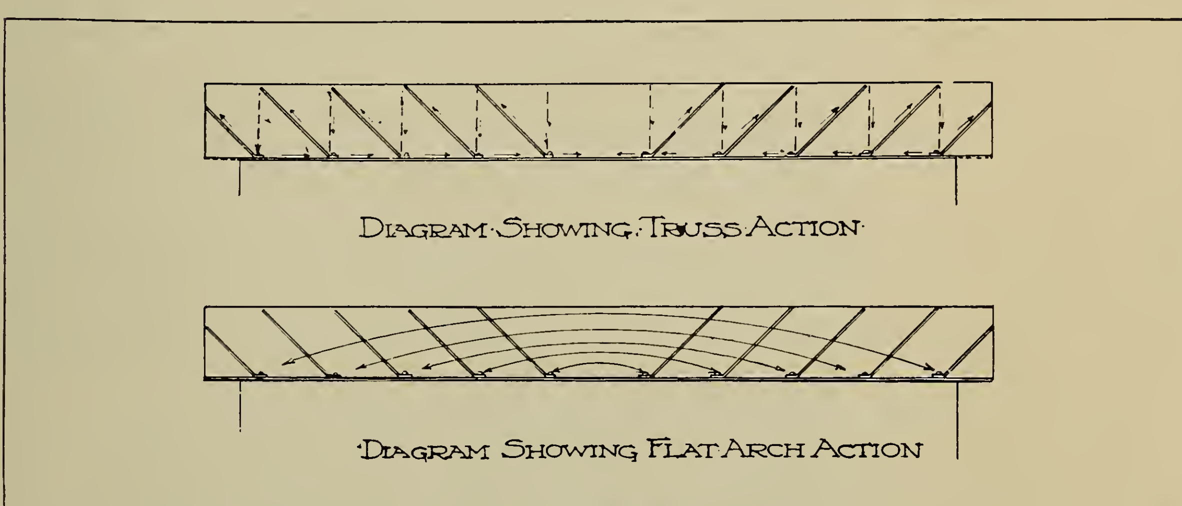


Fig. 3.

direction inclined to the horizontal, so as to lie more closely along the line of principal tensile stress, for if they lie in exactly this line, they also cut the actual line of rupture at right angles, and are therefore of maximum efficiency in holding together the concrete where its natural tendency is to open up. Furthermore, if such stirrups are to carry stress, they should carry it into some member capable of receiving it, and the bottom chord member or the horizontal reinforcement is there for that purpose. In the first place, then, it seems to the writer that stirrups should be inclined to the vertical and preferably bent to a curvature to approximate the line of principal tensile stress, and secondly, these stirrups should be rigidly connected to the main horizontal reinforcing bar.

There is still another matter in connection with the steel reinforcement for concrete beams, which is also of great importance, in so far that it affects economy in the use of steel. In a uniformly loaded beam, the maximum bend-

ing moment occurs at the center, whereas the maximum shear occurs at the ends, and if the same quantity of steel reinforcement is therefore placed along the bottom of the beam and extends the full length of it, it does seem to the writer that steel has been wasted so far as bending moment alone is concerned, and certainly the beam has been neglected so far as shear is concerned. A steel I beam in this manner is not an economical construction for uniform loading; its top and bottom flanges are only required at the center and at this place only a very thin web, whereas at the ends the stress is almost altogether shear, and web alone is required with very little of top and bottom flanges.

In the system of concrete reinforcement, which it is the purpose of this pamphlet to describe, these two matters have been carefully considered. The fundamental principles of this type of reinforcement are:

1st. Concrete should be reinforced in a vertical plane, as well as in a horizontal one.

2nd. The reinforcement should be inclined to the vertical, preferably with varying upward curvature, approximating the line of principal tensile stress.

3rd. The metal should be distributed in proportion to the strains existing at any place.

4th. The shear members should be rigidly connected to the horizontal reinforcement steel.

It has been endeavored to accomplish all of these results by taking a bar of cross section, as shown in Figure 2, and shearing upwards into an inclined position the web on both sides of the main body, thereby forming substantially the tension members of the ordinary Pratt Truss. When such a structural member is embedded within a body of concrete, the latter unites firmly to the steel, and the combination of the two forms a trussed beam wherein the tensional members are made up of steel, and the missing compression members supplanted by the concrete. Concrete is excellent in compression; steel, in tension; and, thanks to the property of strong adhesion between the two, in their combination is made a most ideal beam.

Neglecting for a moment the matter of vertical reinforcement, it is very evident that a bar sheared up as above described, can not possibly slip through the concrete. The writer has actually taken blocks of concrete, moulded to form the voussoirs of a flat arch, and then set them between the prongs. Such a beam, though set up without a particle of mortar between the joints, will carry a very heavy weight, and were it not for the large deflection which is caused by the poorly fitting surfaces between the prongs and blocks, such a beam would carry weights to the same extent and on the same principle as when steel and concrete are actually united together.

And this presents another way of looking at the reasons why this method of reinforcement is so efficient. As soon as a load is applied on top of the

beam, the concrete tends to arch itself, and a series of internal arches immediately set themselves up within the material, each arch finding its abutment in a set of prongs for which the bottom chord acts as a tie. The prongs receive the weight and carry it upwards, distributing it on the other arches of larger span, the horizontal reinforcement serving as a common tensional member. It is plainly evident that with this construction the horizontal member might actually be placed entirely outside of the concrete, and the adhesion of the concrete to it entirely neglected, the strains coming into it being so largely the horizontal components of the inclined members. Of course, for fire proofing purposes, and to prevent rusting, it is more advisable to imbed the steel within the concrete, and when this is done, advantage may be taken of both the adhesion of the concrete to the main bar and to the sheared up members. In fact, with a given amount of concrete, a maximum amount of steel may be used, since the strains which it takes up are due to the direct adhesion of the concrete to it, plus the horizontal component of the inclined members. When such a beam fails, assuming that good material has been used for its construction, one of two things must happen,—either the steel pull in two, or the concrete crush on top. The top portion of a concrete beam when used in floor construction, is largely the floor itself, and it is generally impossible for this to fail in compression. It would seem, therefore, that a very large quantity of steel could be placed in the bottom of the beam to balance the compression. In fact, in all tests which the writer has made up to date, he has pulled the steel in two at the center of the beam.

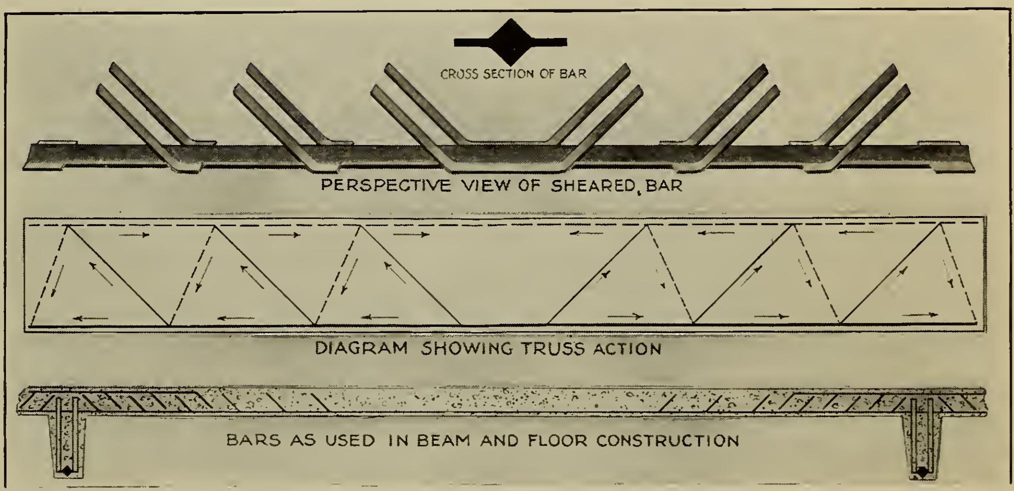


Fig. 3a.

Another point of great advantage of this construction is the fact that a beam need not necessarily be very wide to carry a given load; depth alone counts to advantage. The steel reinforcement, depending entirely upon the stresses coming into it from the sheared up members, may be one large bar. This is practically impossible with constructions wherein the stresses coming into the steel are due to adhesion only of the concrete to it. Where such adhesion is depended upon, a large body of concrete must surround the steel to be able to

transmit all of the strain which the bar is capable of taking. Whatever strain exists in the steel must be transmitted into the upper portion of the concrete immediately surrounding it, and any one can readily perceive the enormity of the horizontal shear, which must therefore exist throughout the body of the concrete, and the necessity of giving this great width. With this new method of concrete reinforcement, however, the beam may be comparatively narrow; in fact, at the bottom it needs only to be sufficiently wide to encase the steel. It should taper upwards, however, widening towards the top, so that sufficient area may be given to the concrete to receive the compression. This, of course, makes a remarkable saving in the amount of this material used.

The strength of steel is, of course, a definitely determined matter. As for the concrete, it is not very expensive, and it would be advisable in all cases to give a small surplus of this material on the top of a beam, so that it will not fail by compression. With shear thus properly cared for, there is only one way in which the beam can possibly fail, and that is by the parting of the steel. Where this result can be assured with certainty, a concrete beam need no longer be subjected to a factor of safety of "ten": the ordinarily adopted factor of "four" is sufficient, as such a beam is entirely dependent upon the steel and should be subject to close calculation in the same manner as a steel I beam or truss. When a concrete beam fails by shear, as has occurred almost without exception in tests up to date, then indeed, the engineer stands more or less in mystery. In general it seems to the writer that whenever concrete is depended upon to carry other strains than direct compression, more or less risk is being assumed by the designing engineer, and a large factor of safety is strongly recommended.

Some photographs are submitted herewith of tests made on two reinforced concrete beams, of twenty-six feet span, center to center of supports, with a four-inch thick concrete slab five feet wide on top to receive the load. The concrete was made of Portland cement, sand, and crushed stone, proportioned one, two and five. Loading was done with pig iron. Deflections measured at the center. In one of the photographs, an outline is shown of the actual cross sections of the beams. The ends, it will be noted, are built up solid to give better bearing on the supporting timbers. The area of metal in the bottom of each beam was two square inches. No deflection whatever could be observed in the beams until the load had reached 48,000 pounds. When 84,000 pounds of pig iron had been loaded on the beams, making a total weight of 93,000 pounds thereon, the floor slab, weighing about 9,000 pounds, the actual deflection was five-eighths of an inch. It was evident that the elastic limit of the steel had been well exceeded by this time. With 101,100 pounds of pig iron, plus 9,300 pounds for weight of slab, making a total load of 110,400 pounds, the beam failed, breaking at the center, and pulling the steel in two at this point. Not a sign of a crack was to be seen throughout the beam at any other place than at the point of failure. This seems to the writer a very remarkable test. The absolute lack of even a hair-like crack throughout any portion of the beam, except at the place of failure, is clear evidence that shear was properly provided for.

As has already been explained, with this method of reinforcement, the adhesion of the concrete to the horizontal steel member is not essential; in fact, if the latter were placed entirely outside of the concrete, the beam would be very nearly as efficient, as the strain which comes into this lower chord is so largely the summation of the horizontal components of the inclined members.

This principle is utilized in the Kahn patented trussed lintel, drawings and photographs of which are presented herewith. In the old system of lintels, an I beam or built-up girder was figured on to carry the weight of the superimposed load and a 12x¼ inch or other similar plate was riveted to the bottom flanges of the beam to give bearing for the wall above, but the plate was counted upon as rendering little or no service in strengthening the lintel. In the new system this bearing plate not only supports the brick-work directly, but also acts as the bottom flange of a masonry beam, in which the masonry takes up the compression or thrust of a flat arch, while the steel plate takes up the tension. Diagonals, riveted to the base plate, form abutments for a series of arches of stress, which set themselves up within the masonry, and for these the base plate serves as the bottom chord or tie. Each diagonal carries its weight upwards on the principle of the ordinary truss and spreads it on other arches of larger span, each of which has its corresponding abutment in a set of diagonals.

Another way of looking at the steel reinforcement for such a masonry beam, is to regard it as a half truss, made up of tension members only, the masonry supplying the missing compression members, and the two being firmly united to each other through the cement, which forms a perfect bond between them.

One of the photographs submitted herewith shows such a lintel, consisting of a 12″x¼″ steel plate, to which 1″x¼″ diagonal members were riveted. The span was twelve feet, height of lintel eleven inches, breadth thirteen inches. Steel billets weighing 110 to 170 pounds were loaded on the beam until a total weight of 40,720 pounds was reached, equal to 3,400 pounds per linear foot of beam. The deflection was ¼ inch. Loading was stopped at this point, as the beam was beginning to be very top heavy, and it was feared might turn over and injure the workmen.

The above systems of concrete reinforcement which have been described are controlled by patents granted and now pending, which are held by the Trussed Concrete Steel Company, Union Trust Building, Detroit, Mich.

Fig. 4.

Showing method of failure for concrete, reinforced in accordance with old systems, using twisted rods. Span 18 feet.

Figures 4, 5, and 6, show tests made at Washington by the United States Engineers, on reinforced concrete beams and slabs, wherein twisted steel rods had been placed along the bottom of the floor. The methods of failure and reasons for it will at once become apparent to the engineer or architect. No matter how much horizontal reinforcement might have been placed in these floors, their strength would not have been increased. The probability is that their strength would have been greatly decreased, as the multiplicity of rods

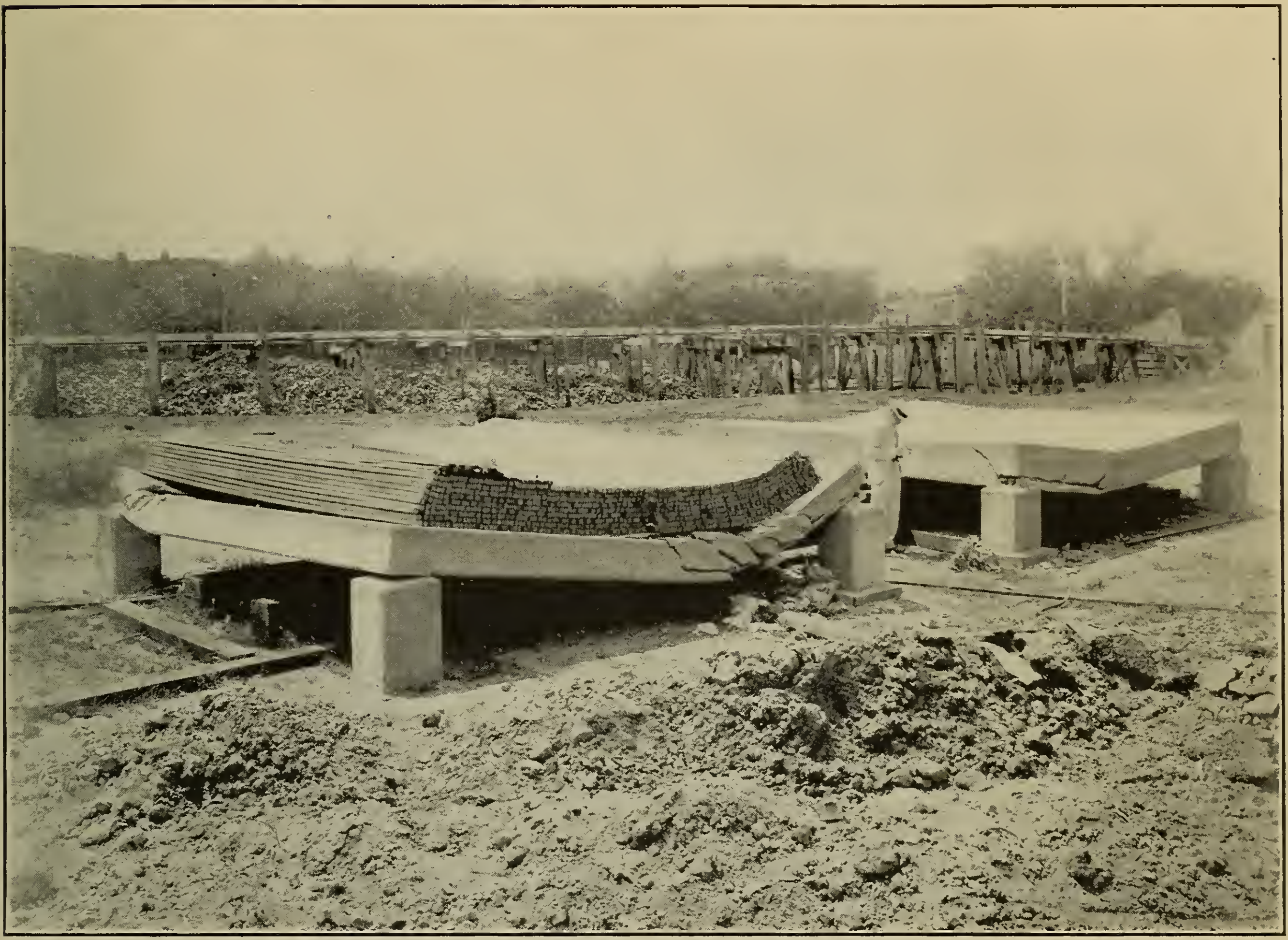


Fig. 5.

Failure of concrete by shear, reinforcement horizontal only, using deformed rods.

would only have cut up the concrete at the bottom, wherein the enormous shearing strain existed, to which attention has already been called. The floors failed by longitudinal shear along the ends of the rods where this is maximum. All the twisting in the world would not have prevented it, nor would this twisting, to the slightest extent, have decreased the vertical shear, which, it is very apparent, was fundamental in the cause of failure. It is unscientific to neglect this matter of shear, and to imagine that concrete

Fig. 6.

Note failure of concrete when horizontal reinforcement only is used. Lines of failure correspond to lines of principal compressive stress.

within itself is capable of taking this strain. Tests for shear have developed strengths remarkably low. The writer has never been able to secure results of more than 200 to 400 lbs. per square inch. Why, therefore, assume such risk in reinforced concrete? There is only one way to prevent failures such as have been shown in these photographs, and that is by strengthening the floors both longitudinally and horizontally for shear, as well as bending moment; and this, it is believed, has been well accomplished by the Kahn system of Trussed Reinforcement.

Fig. 7.

Beams reinforced with Kahn System. Span 26 feet. Load, pig iron.

Figure 7, 8, 9 and 10 show tests of the same nature, made on two beams strengthened in accordance with the Kahn system of reinforcement These beams were 26 feet span. Please note the comparison of loadings between them and the floors of 18 feet span with twisted rods. When failure occurred in these beams, the rupture was absolutely central. The steel pulled in two. Not a sign of a crack was to be observed throughout the beam at any other point. Maximum efficiency was, therefore, given to the strength of the beam. The accomplishing of this result is of especial interest to the engineer, from the fact that he can design with certainty. If the steel pulls in two, he can calculate the strength of the concrete beam with the same accuracy as the steel I beam. Even more so; for the I beam, under test to ultimate destruction, will buckle in its top flange long before the bottom flange pulls in two.

FIG. 8.

Two beams reinforced with Kahn System. Span 26 feet.

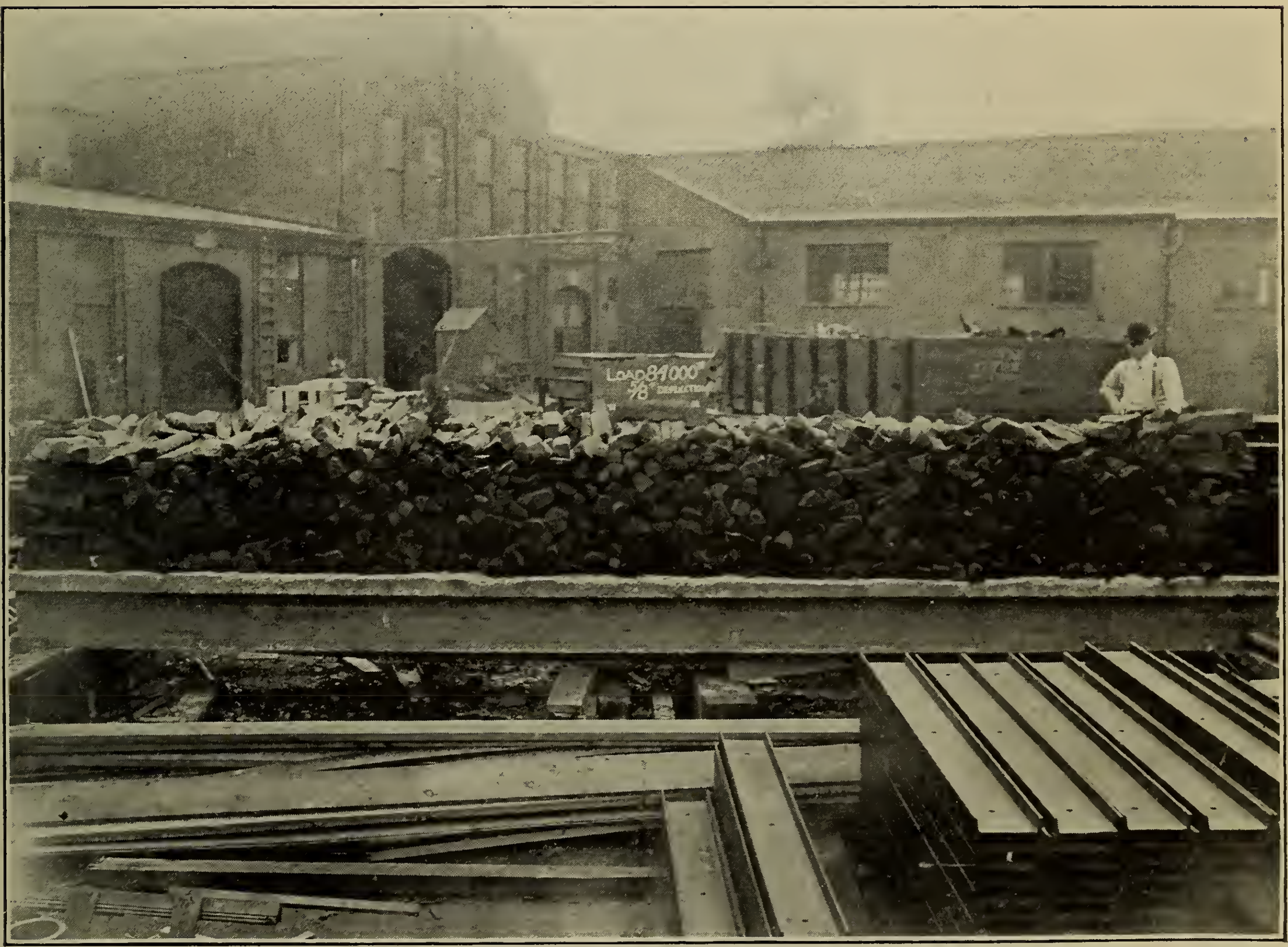


Fig. 9.

Load 84000 lbs. pig iron on two Kahn reinforced beams. Compare these with Fig. 6 where span is only 18 feet.

FIG. 10.

Failure of two Kahn reinforced beams

Load:	Pig iron	101100 lbs.
	Weight of floor slab	9300 lbs.
	Total weight on beams	110400 lbs.

Beam failed in center pulling four bars of steel in two. Compare with Fig. 6.

Fig. 11.

Figure 11 shows the Kahn patented Trussed Bar. It is very interesting to note how readily it adapts itself to all types of construction. Its application to columns, walls, latticed girders and trusses is fully as simple as its application to beams. Where a column is to be constructed, the bars are set in the corners of the concrete, and the shear members extend across the body, forming practically a latticed column. The reasons for the efficiency of such a column will be very apparent. Under ordinary circumstances, a steel bar is steadied at points very closely together, then the entire strength of the steel can practically be developed. This result is accomplished in the steel reinforcement of a column, due to the hold of the concrete on the prongs. Furthermore, when the concrete tends to buckle, the steel comes into play on the principle of the ordinary latticed girder. In other words, the steel and concrete mutually reinforce each other.

Where moving loads are to be taken into account, it is best to place Kahn Trussed Bars in both the bottom and top of the beams, thereby producing practically a latticed girder.

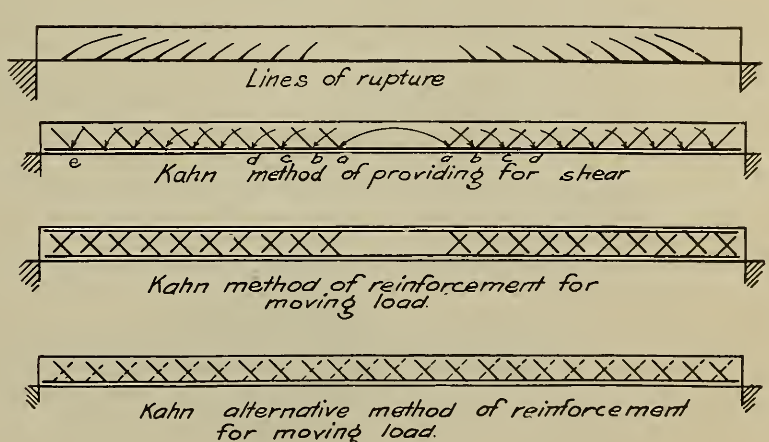
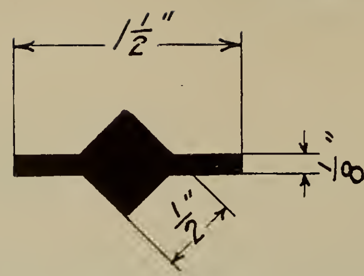
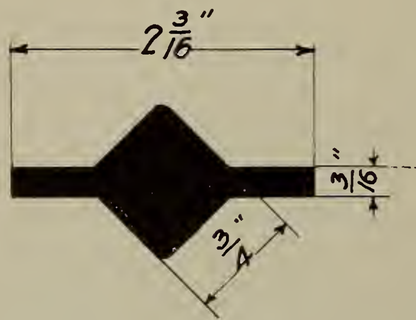


Fig. 12.

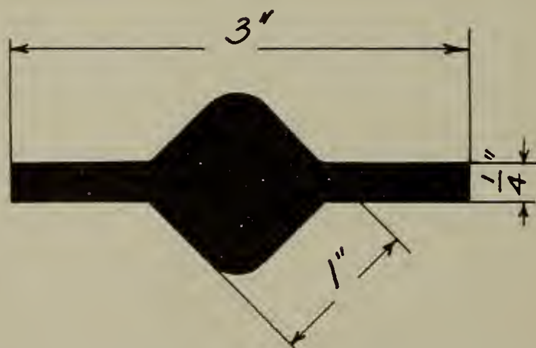


$1\frac{1}{2}$"×$\frac{1}{2}$". Area .38□" Weight 1.4# per ft.



These bars can have any standard size cuts as shown in Figure 14 and will be sent in lengths as ordered. In making calculations for strength of reinforced beam, assume the area of the entire cross section as here given.

$2\frac{3}{16}$"×$\frac{3}{4}$". Area .78□" Weight 2.7# per ft.



3"×1". Area 1.42□" Weight 4.8# per ft.

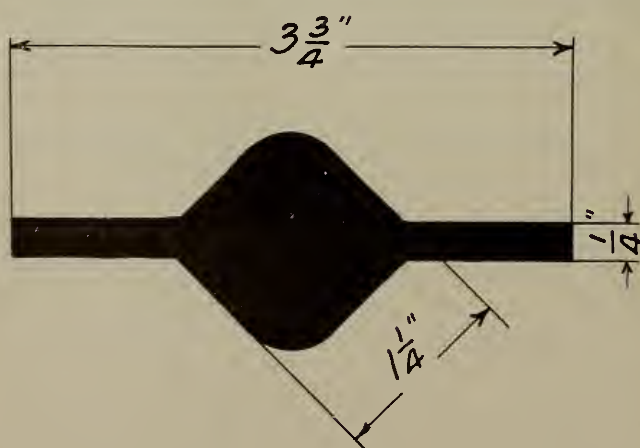
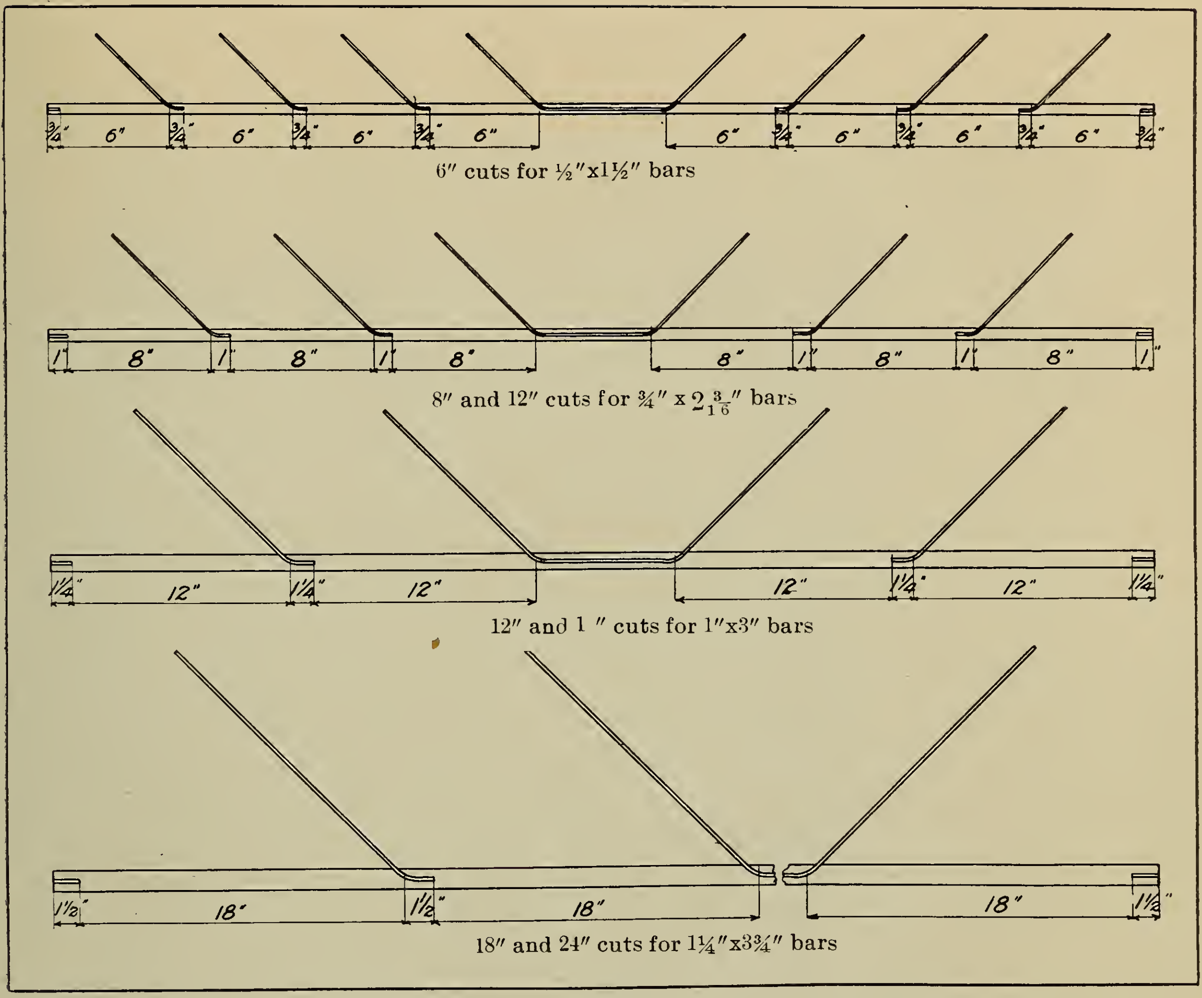


Fig. 13. $3\frac{3}{4}$"×$1\frac{1}{4}$". Area 2.0□" Weight 6.9# per ft.

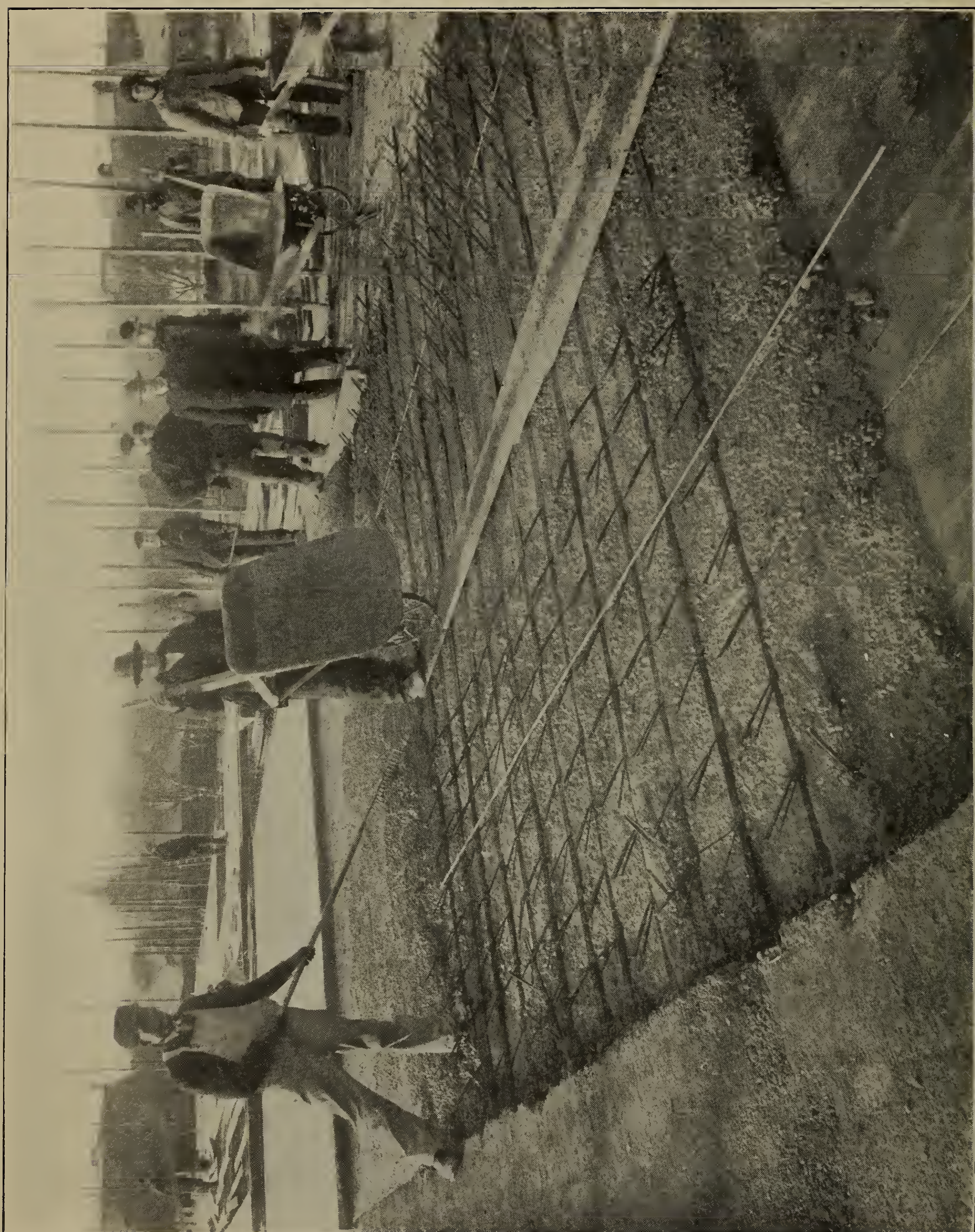


Bars kept in stock ready for immediate delivery, in any lengths with standard cuts.

FIG. 14.

Figure 13 shows standard sections of the Kahn Trussed Bars. Practically any construction can be built by using one of the four sizes shown and sheared up as is indicated in Figure 14. The equivalent of Steel Beams from 6 inches to 20 inches can be built up with reinforced concrete, using one or more of these bars placed in the bottom, or on the tension side.

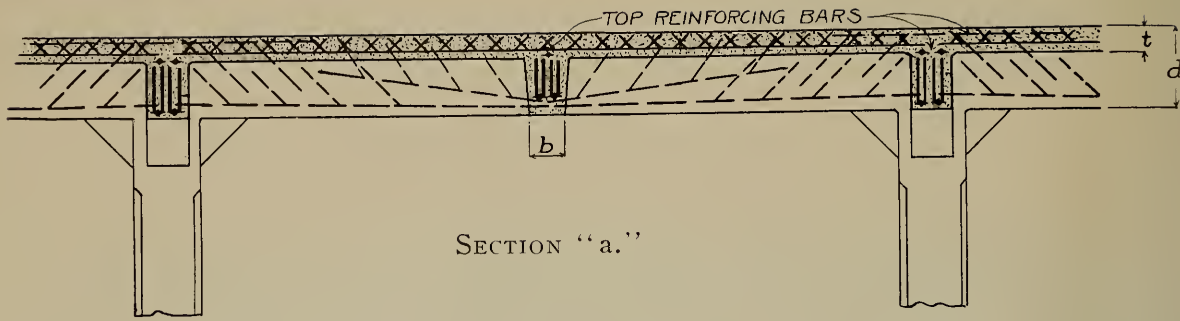
Figure 14 shows standard cuts. It will be noticed that the largest is 18 inches. Where deeper girders are wanted, it will be well to lay some of the rods horizontally all the way along the bottom, and others slanting upwards from the bottom towards the ends of the beam, thereby distributing the shear members throughout the beam, and causing them to reach its very top.



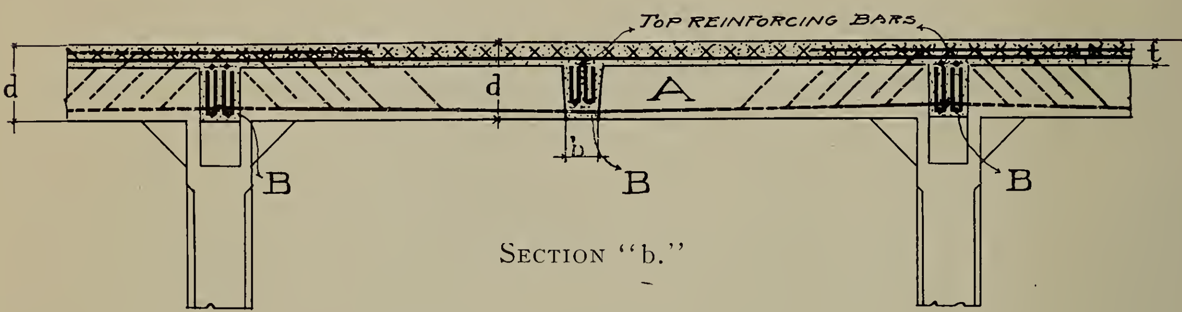
View showing the method of laying Kahn Trussed Bars as applied to concrete floor slabs.
Span 16 feet, thickness of slab 6 in., bars 14 in. on centers.

See next cut for test made on these floors.

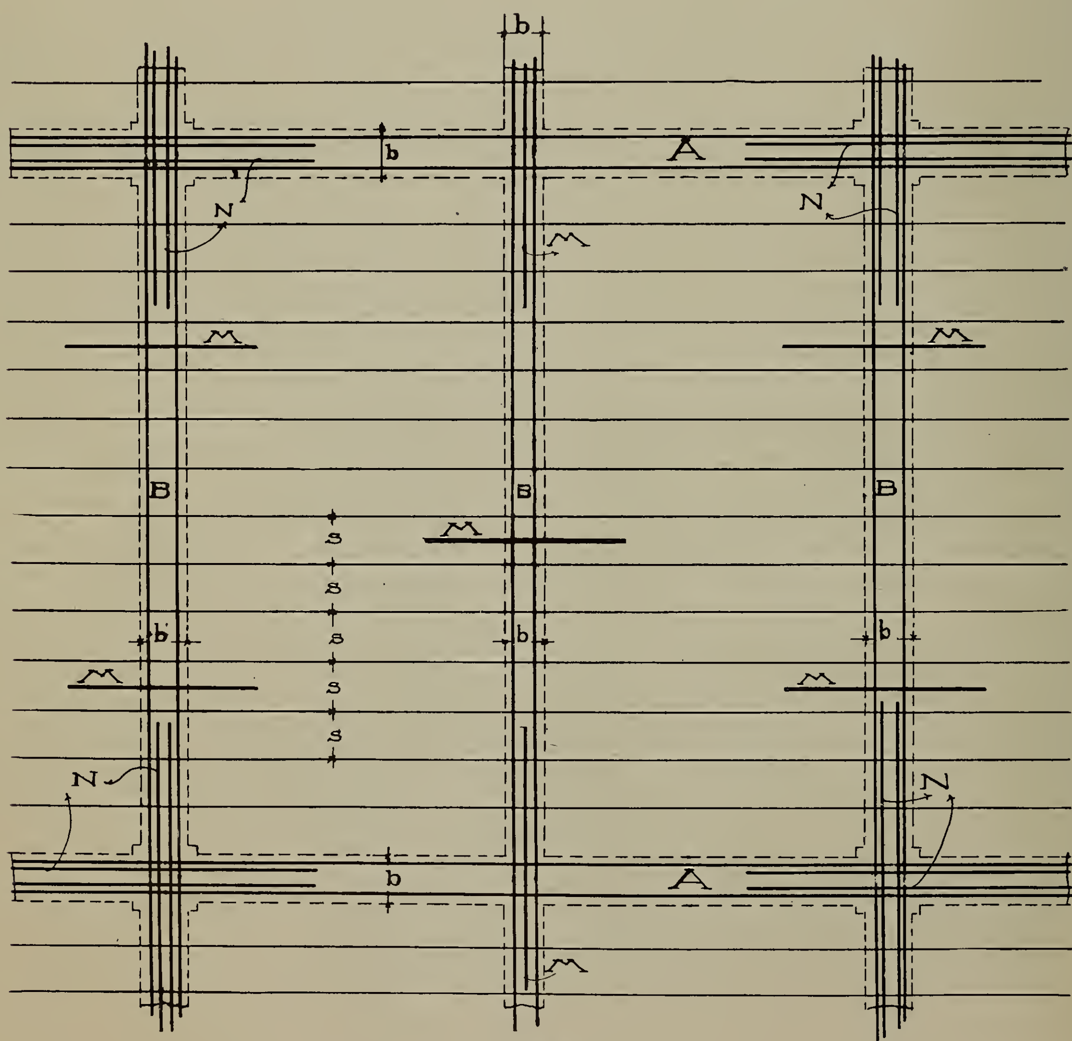
Test load on floor reinforced with ¾ in. x 2¼ in. Kahn Trussed Bars. Span 16 ft., thickness of slab 6 inches, bars 14 in. on centers. Total load 26 tons, equals 850 lbs. per square foot. No deflection. Floor intended to carry safe load of 125 lbs. per square foot.



Section "a."



Section "b."



Plan

Fig. 15.

Note.—For extra heavy beams place one or two short bars in girder as shown in Section "a."

Tables giving sizes and reinforcement for square panels, according to the Kahn System of Reinforced Concrete

Type I

Panel 16′x 16′ between Supports

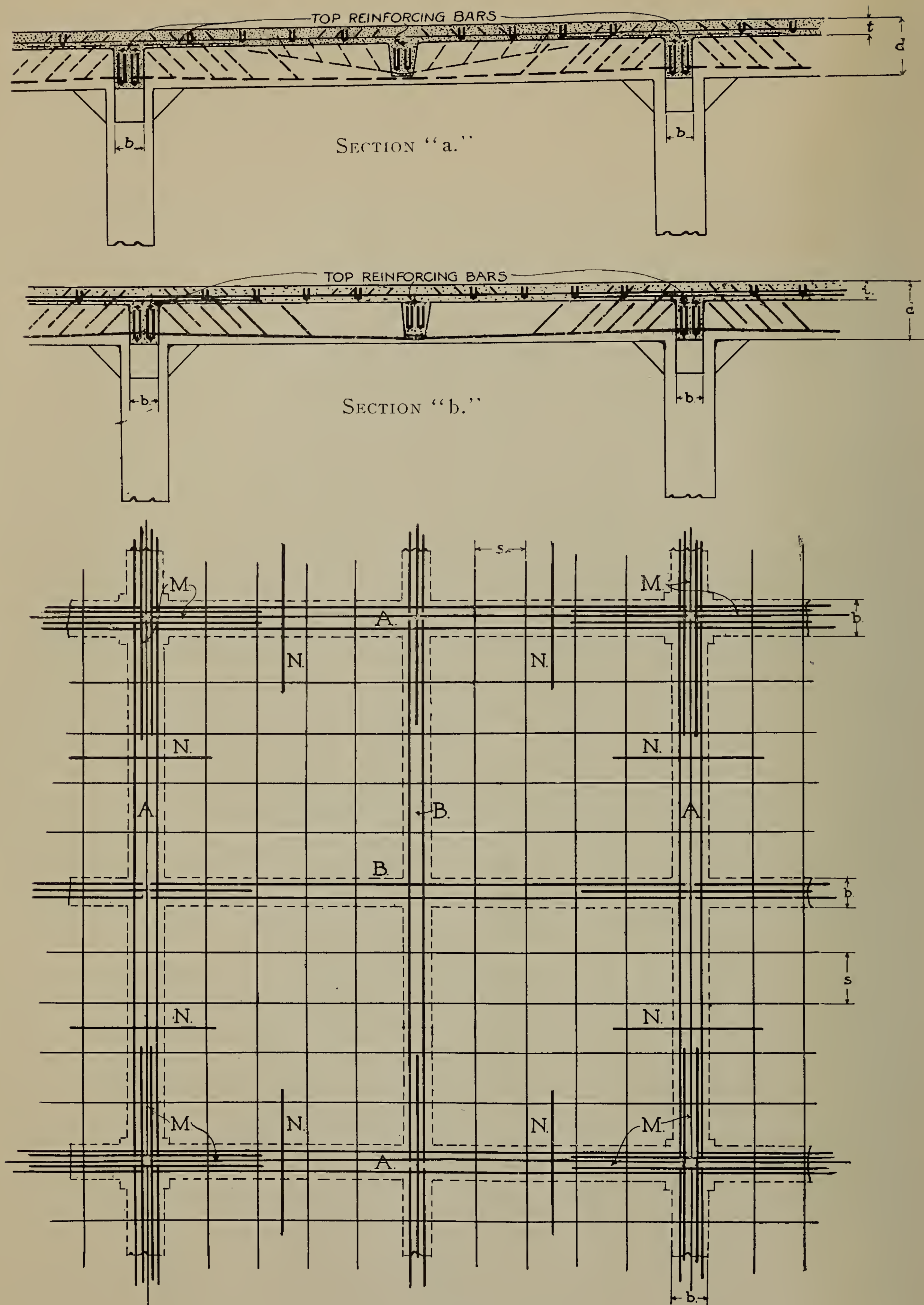
Safe Live Load per square foot	Beam A			Beam B			Floor Slab			Pounds of Steel per sq. ft.	Cubic feet of Concrete per sq. ft.
	b	d	Steel	b	d	Steel	t	s	Steel		
175	12	20	2—1¼″x3¾″	10	13	2—1″x3″	4″	16″	½″x1½″	3.60	0.48
200	12	22	2—1¼″x3¾″	10	14	2—1″x3″	4″	16″	½″x1½″	3.60	0.50
225	12	24	2—1¼″x3¾″	10	16	2—1″x3″	4″	16″	½″x1½″	3.60	0.53
250	16	18	3—1¼″x3¾″	10	18	2—1″x3″	4″	14″	½″x1½″	4.17	0.53
300	16	22	3—1¼″x3¾″	10	20	2—1″x3″	4″	12″	½″x1½″	4.37	0.58
350	16	24	3—1¼″x3¾″	10	24	2—1″x3″	4″	10″	½″x1½″	4.65	0.62

Panel 18′x 18′ between Supports

Safe Live Load per square foot	Beam A			Beam B			Floor Slab			Pounds of Steel per sq. ft.	Cubic feet of Concrete per sq. ft.
	b	d	Steel	b	d	Steel	t	s	Steel		
150	12	24	2—1¼″x3¾″	10	16	2—1″ x3″	4″	16″	½″x1½″	3.26	0.50
175	12	28	2—1¼″x3¾″	10	18	2—1″ x3″	4″	16″	½″x1½″	3.26	0.54
200	16	21	3—1¼″x3¾″	10	20	2—1″ x3″	4″	14″	½″x1½″	3.80	0.55
225	16	24	3—1¼″x3¾″	10	22	2—1″ x3″	4″	12″	½″x1½″	4.00	0.58
250	16	26	3—1¼″x3¾″	12	18	2—1¼″x3¾″	4″	11″	½″x1½″	4.59	0.58
300	16	30	3—1¼″x3¾″	12	22	2—1¼″x3¾″	4″	9″	½″x1½″	4.93	0.64
	20	23	4—1¼″x3¾″							5.31	0.63

Top Reinforcing Bars { In Slab over Beams, 3 Bars, ½″x1½″ x4′0″ long
" Beams " Supports, 5 " ¾″x$2\frac{3}{16}$″x8′0″ "

See Fig. 15.



Section "a."

Section "b."

Plan.

Fig. 16.

Note.—For extra heavy beams place one or two short bars in girder as shown in Section "a,"

Tables giving sizes and reinforcement for square panels, according to the Kahn System of Reinforced Concrete

Type II

Panel 20′ x 20′ between Supports

Safe Live Load in lbs. per sq. ft.	Beam A b	Beam A d	Beam A Steel	Beam B b	Beam B d	Beam B Steel	Floor Slab t	Floor Slab s	Floor Slab Trus. Con. Bars	Pounds of steel per sq. ft. T	Pounds of steel per sq. ft. K	Cubic feet of Concrete per sq. ft.
150	12	24	2—1¼″ x 3¾″	8	19	2—¾″x2$\frac{3}{16}$″	4″	12″	½″	1.62	2.30	0.58
175	12	28	2—1¼″ x 3¾″	8	22	2—¾″x2$\frac{3}{16}$″	4″	10″	½″	1.94	2.30	0.63
200	16	22	3—1¼″ x 3¾″	10	14	2—1″x3″	4″	9″	½″	2.16	3.41	0.60
225	16	24	3—1¼″ x 3¾″	10	16	2—1″x3″	4″	8″	½″	2.43	3.41	0.63
250	16	26	3—1¼″ x 3¾″	10	18	2—1″x3″	4″	7″	½″	2.78	3.41	0.67
300	16	30	3—1¼″ x 3¾″	10	20	2—1″x3″	4″	6″	½″	3.24	3.41	0.73

Panel 24′ x 24′ between Supports

Safe Live Load in lbs. per sq. ft.	Beam A b	Beam A d	Beam A Steel	Beam B b	Beam B d	Beam B Steel	Floor Slab t	Floor Slab s	Floor Slab Trus. Con. Bars	Pounds of steel per sq. ft. T	Pounds of steel per sq. ft. K	Cubic feet of Concrete per sq. ft.
100	16	20	3—1¼″x3¾″	8	20	2— ¾″x2$\frac{3}{16}$″	4″	12″	½″	1.62	2.44	0.55
125	16	24	3—1¼″x3¾″	10	14	2—1 ″x3″	4″	10″	½″	1.94	2.79	0.57
				8	24	2— ¾″x2$\frac{3}{16}$″					2.44	0.61
150	16	28	3—1¼″x3¾″	10	18	2—1 ″x3″	4″	8″	½″	2.43	2.79	0.63
175	20	25	4—1¼″x3¾″	10	20	2—1 ″x3″	4″	7″	½″	2.78	3.36	0.67
200	20	28	4—1¼″x3¾″	10	22	2—1 ″x3″	4″	6″	½″	3.24	3.36	0.71

Panel 22′ x 22′ between Supports

Safe Live Load in lbs. per sq. ft.	Beam A b	Beam A d	Beam A Steel	Beam B b	Beam B d	Beam B Steel	Floor Slab t	Floor Slab s	Floor Slab Trus. Con. Bars	Pounds of steel per sq. ft. T	Pounds of steel per sq. ft. K	Cubic feet of Concrete per sq. ft.
125	12	28	2—1¼″x3¾″	8	20	2— ¾″x2$\frac{3}{16}$″	4″	11″	½″	1.77	2.05	0.59
150	16	22	3—1¼″x3¾″	10	14	2—1 ″x3″	4″	9″	½″	2.16	3.07	0.57
175	16	25	3—1¼″x3¾″	10	16	2—1 ″x3″	4″	8″	½″	2.43	3.07	0.62
200	16	28	3—1¼″x3¾″	10	18	2—1 ″x3″	4″	7″	½″	2.78	3.07	0.66
250	20	26	4—1¼″x3¾″	10	22	2—1 ″x3″	4″	6″	½″	3.24	3.70	0.72

Panel 26′ x 26′ between Supports

Safe Live Load in lbs. per sq. ft.	Beam A b	Beam A d	Beam A Steel	Beam B b	Beam B d	Beam B Steel	Floor Slab t	Floor Slab s	Floor Slab Trus. Con. Bars	Pounds of steel per sq. ft. T	Pounds of steel per sq. ft. K	Cubic feet of Concrete per sq. ft.
75	12	30	2—1¼″x3¾″	8	20	2— ¾″x2$\frac{3}{16}$″	4″	12″	½″	1.62	1.70	0.56
100	16	26	3—1¼″x3¾″	10	16	2—1 ″x3″	4″	10″	½″	1.94	2.54	0.58
125	20	24	4—1¼″x3¾″	10	18	2—1 ″x3″	4″	8″	½″	2.43	3.09	0.62
150	20	27	4—1¼″x3¾″	10	22	2—1 ″x3″	4″	6″	½″	3.24	3.09	0.67
175	20	31	4—1¼″x3¾″	10	26	2—1 ″x3″	4″	5″	½″	3.89	3.09	0 73

Top Reinforcing Bars { In Slab over Beams. Bars ½″ x 1½″ x 4′ 0″ long. N
{ In Beams. Bars ¾″ x 2$\frac{3}{16}$″ x 8′ 0″ long. M

See Fig. 16.

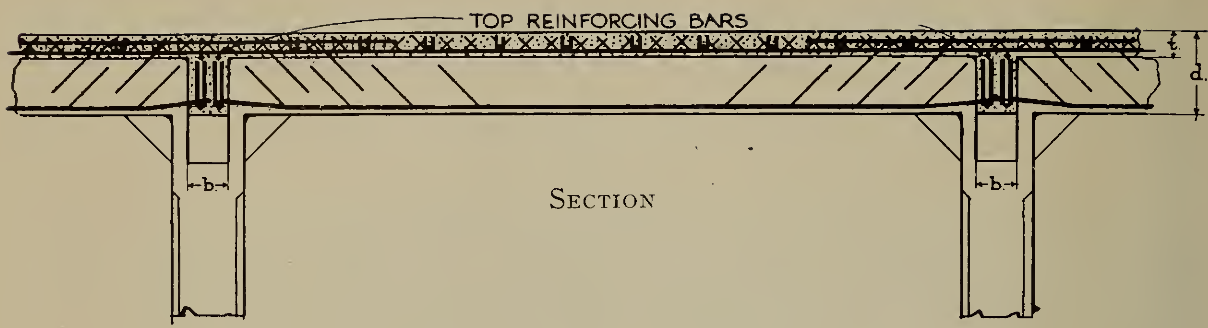
T=Weight of Trus-con. Bars

K= " " Kahn Trussed Bars

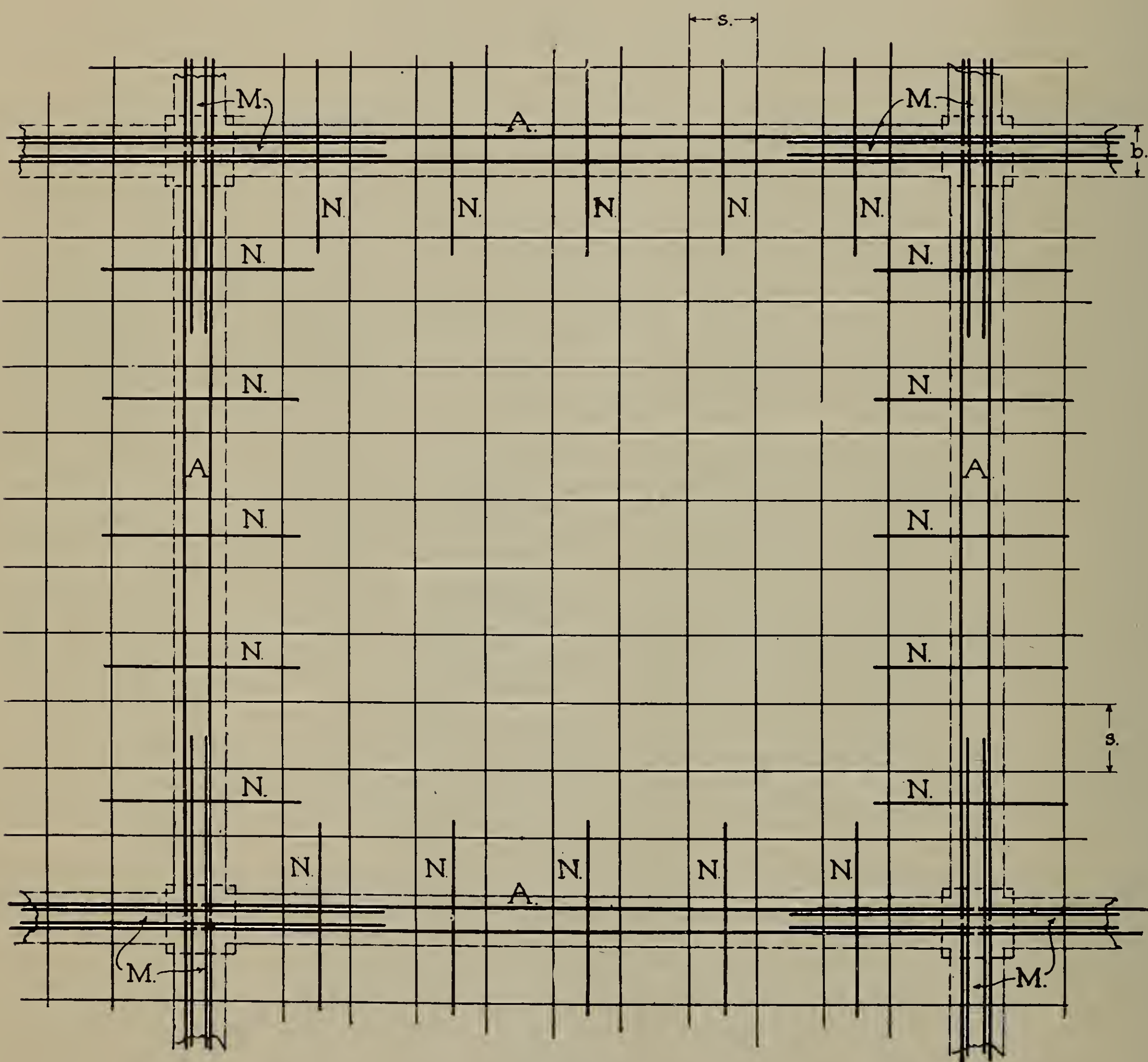
If load is moving or concentrated, use ½″x 1½″ Kahn Trussed Bars in place of Trus-con. Bars, in slab. Spacing as shown.

See special catalog of Trus-con. Bars.

III



Section



Plan.

Fig. 17.

See note on bottom of page 28.

Tables giving sizes and reinforcement for square panels, according to the Kahn System of Reinforced Concrete

Type III

Panel 12' x 12' between Supports

Safe Live Load in lbs. per sq. ft.	Beam A			Floor Slab			Pounds of Steel per square foot	Cubic feet of Concrete per square foot
	Size		Steel	t	Spacing Bars	Steel		
	b	d						
150	6	14	2—$\frac{1}{2}$"x1$\frac{1}{2}$"	4"	16"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.25	0.41
175	6	18	2—$\frac{1}{2}$"x1$\frac{1}{2}$"	4"	16"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.25	0.43
200	6	19	2—$\frac{1}{2}$"x1$\frac{1}{2}$"	4"	15"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.39	0.44
250	8	12	2—$\frac{3}{4}$"x2$\frac{3}{16}$"	4"	12"	$\frac{1}{2}$"x1$\frac{1}{2}$"	4.38	0.40
300	8	15	2—$\frac{3}{4}$"x2$\frac{3}{16}$"	4"	10"	$\frac{1}{2}$"x1$\frac{1}{2}$"	4.94	0.43

Top Reinforcing Bars, { 2 Bars in each Beam, $\frac{3}{4}$"x2$\frac{3}{16}$"x6'0" long M
{ 3 " over " " $\frac{1}{2}$"x1$\frac{1}{2}$" x4'0" " N

Panel 16' x 16' between Supports

Safe Live Load in lbs. per sq. ft.	Beam A			Floor Slab			Pounds of Steel per square foot	Cubic feet of Concrete per square foot
	Size		Steel	t	Spacing Bars	Steel		
	b	d						
100	8	12	2—$\frac{3}{4}$"x2$\frac{3}{16}$"	4"	16"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.29	0.40
125	8	15	2—$\frac{3}{4}$"x2$\frac{3}{16}$"	5"	16"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.29	0.48
150	8	18	2—$\frac{3}{4}$"x2$\frac{3}{16}$"	5"	15"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.42	0.50
175	8	20	2—$\frac{3}{4}$"x2$\frac{3}{16}$"	5"	12"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.99	0.52
200	10	14	2—1"x3"	5"	10"	$\frac{1}{2}$"x1$\frac{1}{2}$"	5.07	0.50

Top Reinforcing Bars, { 2 Bars in each Beam, $\frac{3}{4}$"x2$\frac{3}{16}$"x8'0" long M
{ 4 " over " " $\frac{1}{2}$"x1$\frac{1}{2}$" x4'0" " N

Panel 14' x 14' between Supports

Safe Live Load in lbs. per sq. ft.	Beam A			Floor Slab			Pounds of Steel per square foot	Cubic feet of Concrete per square foot
	Size		Steel	t	Spacing Bars	Steel		
	b	d						
125	8	10	2—$\frac{3}{4}$"x2$\frac{3}{16}$"	4"	16"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.43	0.38
150	8	12	2—$\frac{3}{4}$"x2$\frac{3}{16}$"	4"	14"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.73	0.39
175	8	14	2—$\frac{3}{4}$"x2$\frac{3}{16}$"	4"	13"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.92	0.41
200	8	16	2—$\frac{3}{4}$"x2$\frac{3}{16}$"	5"	14"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.73	0.51
250	10	12	2—1"x3"	5"	11"	$\frac{1}{2}$"x1$\frac{1}{2}$"	4.98	0.49
	8	20	2—$\frac{3}{4}$"x2$\frac{3}{16}$"				4.38	0.53

Top Reinforcing Bars, { 2 Bars in each Beam, $\frac{3}{4}$"x2$\frac{3}{16}$"x6'0" long M
{ 4 " over " " $\frac{1}{2}$"x1$\frac{1}{2}$" x4'0" " N

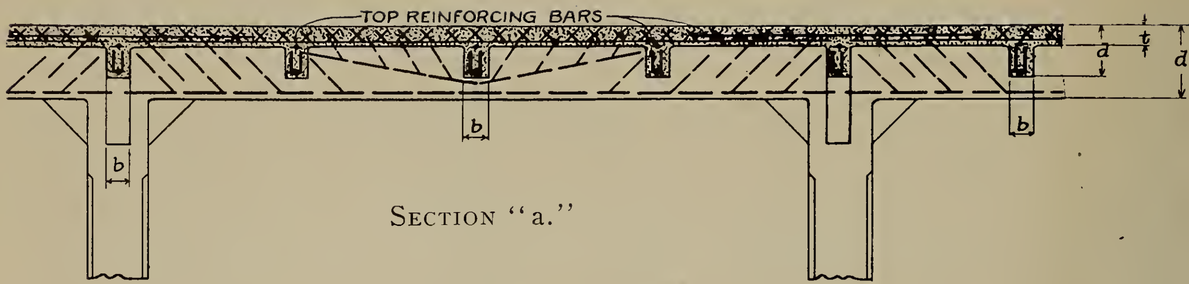
Panel 18' x 18' between Supports

Safe Live Load in lbs. per sq. ft.	Beam A			Floor Slab			Pounds of Steel per square foot	Cubic feet of Concrete per square foot
	Size		Steel	t	Spacing Bars	Steel		
	b	d						
75	8	14	2—$\frac{3}{4}$"x2$\frac{3}{16}$"	5"	16"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.14	0.48
100	8	17	2—$\frac{3}{4}$"x2$\frac{3}{16}$"	5"	16"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.14	0.49
125	10	12	2—1"x3"	6"	16"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.60	0.54
	8	22	2—$\frac{3}{4}$"x2$\frac{3}{16}$"				3.14	0.60
150	10	14	2—1"x3"	6"	14"	$\frac{1}{2}$"x1$\frac{1}{2}$"	3.90	0.56
175	10	17	2—1"x3"	6"	12"	$\frac{1}{2}$"x1$\frac{1}{2}$"	4.30	0.58

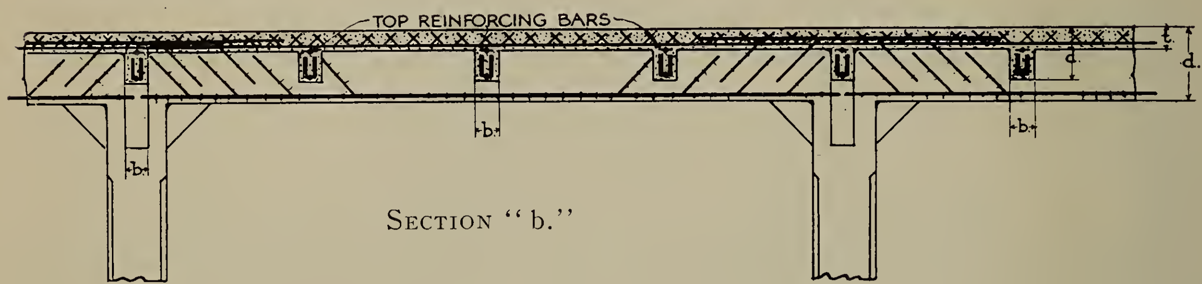
Top Reinforcing Bars, { 2 Bars in each Beam, $\frac{3}{4}$"x2$\frac{3}{16}$"x8'0" long M
{ 5 " over " " $\frac{1}{2}$"x1$\frac{1}{2}$" x4'0" " N

See Fig. 17.

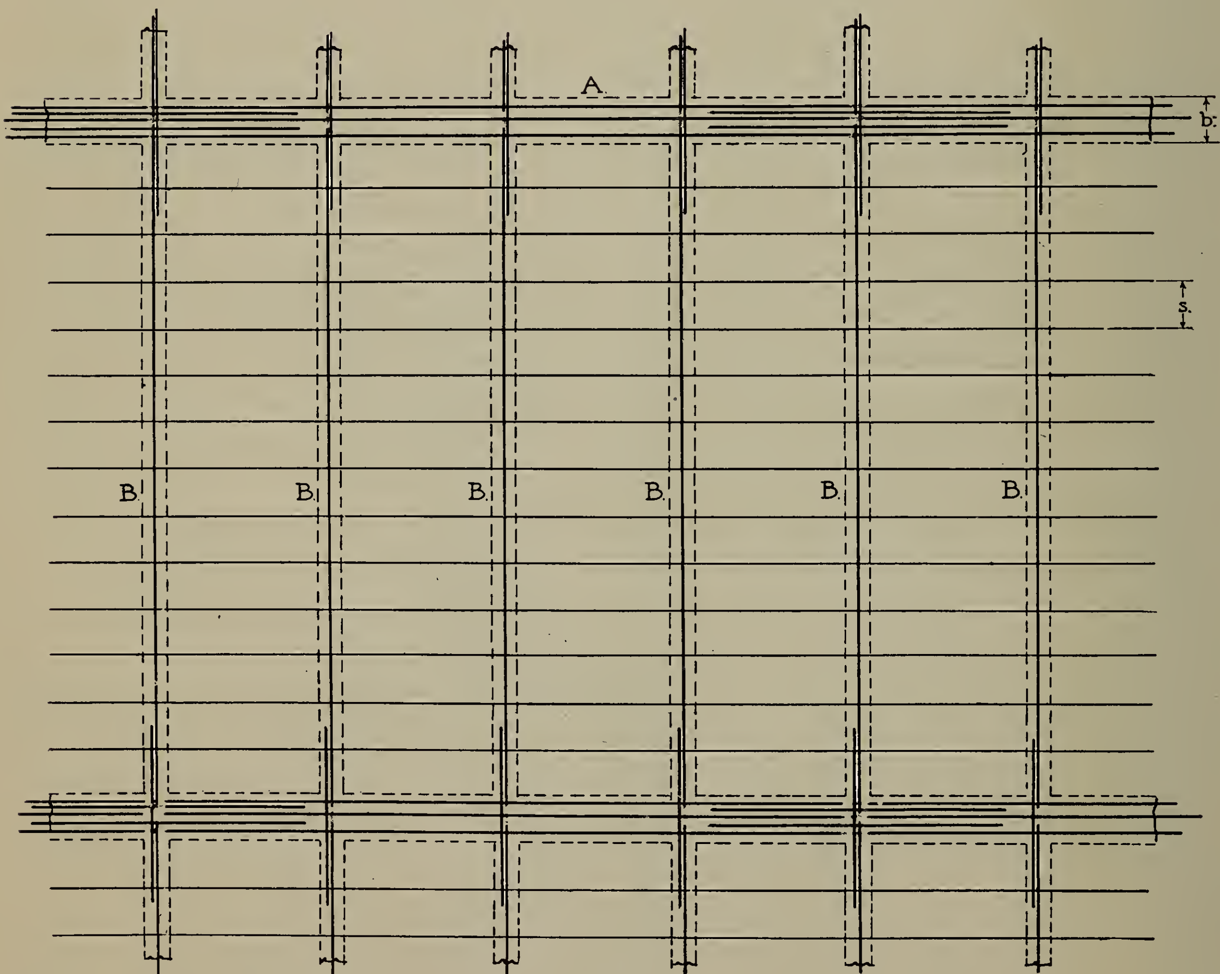
IV



SECTION "a."



SECTION "b."



Plan.

FIG. 18.

NOTE.—For extra heavy beams place one or two short bars in girder as shown in Section "a."

Tables giving sizes and reinforcement for square panels, according to the Kahn System of Reinforced Concrete

Type IV

Panel 16′x16′ between Supports

Safe Live Load in lbs per sq. ft.	Beam A b	Beam A d	Beam A Steel	Beam B b	Beam B d	Beam B Steel	Floor Slab t	Floor Slab s	Floor Slab Trus. Con. Bars	Pounds of steel per sq. ft. T	Pounds of steel per sq. ft. K	Cubic feet of Concrete per sq. ft.
200	12	23	2—1¼″x3¾″	6	14	1—1″ x3″	3″	12″	½″	0.81	2.61	0.45
225	12	25	2—1¼″x3¾″	6	15	1—1″ x3″	3″	12″	½″	0.81	2.61	0.47
250	14	24	3—1″ x3″	6	17	1—1″ x3″	3″	12″	½″	0.81	2.65	0.51
300	16	22	3—1¼″x3¾″	7	14	1—1¼″x3¾″	3″	12″	½″	0.81	3.57	0.50
350	16	24	3—1¼″x3¾″	7	16	1—1¼″x3¾″	3″	12″	½″	0.81	3.57	0.52
400	20	22	4—1¼″x3¾″	7	20	1—1¼″x3¾″	3″	11″	½″	0.88	4.01	0.59

Panel 20′ x 20′ between Supports

Safe Live Load in lbs. per sq. ft.	Beam A b	Beam A d	Beam A Steel	Beam B b	Beam B d	Beam B Steel	Floor Slab t	Floor Slab s	Floor Slab Trus. Con. Bars	Pounds of Steel per sq. ft. T	Pounds of Steel per sq. ft. K	Cubic feet of Concrete per sq. ft.
150	16	22	3—1¼″x3¾″	7	14	1—1¼″x3¾″	3″	12″	½″	0.81	2.77	0.44
175	16	25	3—1¼″x3¾″	7	16	1—1¼″x3¾″	3″	12″	½″	0.81	2.77	0.48
200	16	28	3—1¼″x3¾″	7	19	1—1¼″x3¾″	3″	12″	½″	0.81	2 77	0.52
225	20	24	4—1¼″x3¾″	7	21	1—1¼″x3¾″	3″	12″	½″	0.81	3.11	0.54
250	20	26	4—1¼″x3¾″	7	23	1—1¼″x3¾″	3″	10″	½″	0.97	3.11	0.57

Panel 18′ x 18′ between Supports

Safe Live Load in lbs. per sq. ft.	Beam A b	Beam A d	Beam A Steel	Beam B b	Beam B d	Beam B Steel	Floor Slab t	Floor Slab s	Floor Slab Trus. Con. Bars	Pounds of Steel per sq. ft T	Pounds of Steel per sq. ft K	Cubic feet of Concrete per sq. ft.
200	16	22	3—1¼″x3¾″	6	20	1—1″ x3″	3″	12″	½″	0.81	2.65	0.54
225	16	24	3—1¼″x3¾″	7	16	1—1¼″x3¾″	3″	12″	½″	0.81	3.11	0.50
250	16	26	3—1¼″x3¾″	7	18	1—1¼″x3¾″	3″	12″	½″	0.81	3.11	0.53
300	20	24	4—1¼″x3¾″	7	20	1—1¼″x3¾″	3″	12″	½″	0.81	3.49	0.56
350	20	26	4—1¼″x3¾″	7	23	1—1¼″x3¾″	3″	10″	½″	0.97	3.49	0.61

Panel 22′ x 22′ between Supports

Safe Live Load in lbs per sq. ft.	Beam A b	Beam A d	Beam A Steel	Beam B b	Beam B d	Beam B Steel	Floor Slab t	Floor Slab s	Floor Slab Trus. Con. Bars	Pounds of Steel per sq. ft. T	Pounds of Steel per sq. ft. K	Cubic feet of Concrete per sq. ft.
100	16	20	3—1¼″x3¾″	6	18	1—1″ x3″	3″	12″	½″	0.81	2.10	0.44
125	16	24	3—1¼″x3¾″	6	22	1—1″ x3″	3″	12″	½″	0.81	2.10	0.48
150	16	28	3—1¼″x3¾″	7	19	1—1¼″x3¾″	3″	12″	½″	0.81	2.24	0.50
175	20	24	4—1¼″x3¾″	7	22	1—1¼″x3¾″	3″	12″	½″	0.81	2.79	0.53
200	20	27	4—1¼″x3¾″	7	25	1—1¼″x3¾″	3″	11″	½″	0.88	2.79	0.57
225	20	30	4—1¼″x3¾″	10	20	2—1″ x3″	3″	10″	½″	0.97	3.20	0.61

Top Reinforcing Bars { In Beams "A." Bars, 1″x3″ x8′0″ long
" " "B." " ¾″x2$\frac{3}{16}$″x6′0″ "

See Fig. 18.

T=Weight of Trus-con. Bars
K= " " Kahn Sheared Bars

If load is moving or concentrated, use ½″x1½″ Kahn Trussed Bars in place of Trus-con. Bars, in slab. Spacing as shown.
See special catalog of Trus-con. Bars.

Applications of the Kahn Trussed Bar.

The usages of this bar are so great that it is impossible to illustrate all within this pamphlet. Some of the more important adaptations are herewith noted:

Floor Construction.

The Kahn trussed bar lends itself *admirably* to various forms of floor construction, the most common of which are:

The reinforced concrete slab.

The reinforced hollow tile floor.

Figures 15, 16, 17, 18, represent typical methods of beam arrangement in the solid concrete system.

In selecting from these methods, one should be guided by the length of span required, as well as the load per sq. ft. For instance, the method shown in Fig. 18 is obviously better adapted to long spans and heavy load than that represented by Fig. 17.

The essential points to be noticed in this system of construction and which cannot be obtained by any other system are:

Continuous Slab Action

This is obtained by the crossing of bars and inverting them over all supports, so that a load placed in any panel is distributed in every direction and is carried very largely by the adjoining panels through the cantilever action of the inverted bars. Thus, if a hole were cut out of the slab, if poor concrete were used in any section, or any of the beams utterly destroyed, the floor would still possess a certain factor of safety, owing to the cantilever action of the inverted bars.

Rigidity of Floor Construction

When horizontal reinforcement alone is used, it is reasonable to say that the amount of sag is proportional to the length of the steel bars unsupported; that is, the entire length of the bar. In fact, the horizontal reinforcement does not come into the tension until beams or slabs have become sagged. With the Kahn trussed bar, however, this length is reduced to that portion between the two central diagonal members. For this reason, a deflection under dead weight alone, which is so common in all other systems, is practically impossible with the Kahn trussed bar, where the floor has been properly designed. It is also important to note in this construction the resistance offered to vibration.

Positive prevention against cracking of finished floor over supports

This also is a very common fault in all other systems. The inverted Kahn bars in top of slab over beams give the continuous action which is an invariable proof against its cracking. The effects of temperature is thus taken care of at the most vulnerable points.

Facility of erection

The Kahn trussed bar is the only known reinforcing bar in which both the shear and tension members are combined in one piece. It is needless to say that the saving in cost of erection alone, due to this fact, warrants the exclusive use of this bar. There is no need to depend upon the proper placing of innumerable small members by careless workmen; no need to risk life and success upon the exact mixture of concrete by unskilled laborers. In fact, if by accident, frozen or otherwise objectionable concrete is placed in a structure, there still remains a factor of safety of at least 2 or 3. We challenge any other method of construction to show safety values such as these. The reason for this is that the adhesion, grip, tension, or *mechanical bond* of concrete, are not at all depended upon. This bar needs the concrete in compression only, due to arch action.

Method of failure at tests to destruction

Failure of a structure when reinforced by the Kahn sheared bar, and when tested to destruction, occurs invariably by the breaking of the steel (See Fig. 34), and then only after the steel has stretched about 20 to 25% of its entire length. Collapse or sudden failure is absolutely impossible, as this bar provides positively for shear. The certainty of knowledge that a structure cannot fail without the pulling in two of the steel at the center, thus making correct calculations possible, is sufficient reason why the Kahn sheared bar is being universally adopted as a standard of excellence in reinforcing material for concrete.

Reinforced Hollow Tile Construction.

Figures 19, 20, 21, represent our method of floor construction, No. 2. It is impossible to conceive of a more simple, direct, and beautiful construction than this. It's great advantages are as follows:

Speed of erection

The blocks are laid in rows with a 3″ or 4″ space intervening. Into these spaces is placed an inch of cement mortar and the Kahn trussed bar. They are then filled with a rather rich concrete. We have thus formed reinforced concrete joists, about 16″ on centers. The tile serves merely as filling empty spaces, the floor weight being carried directly by the intermediate beams.

Tables of Safe Live Loads per square foot for Kahn System of Reinforced Hollow Tile Floor Construction

$\frac{1}{2}'' \times 1\frac{1}{2}''$ Bars, 15″ o. c.

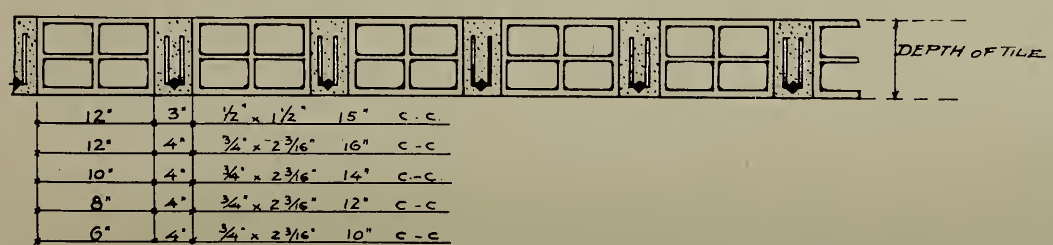
Safe Loads in pounds per square foot

Span in feet	Depth of Tile				
	4″	6″	8″	10″	12″
5	285	490			
6	195	335			
7	140	245			
8	105	185	260	345	430
9	80	140	200	265	330
10	65	110	160	210	265
11		90	130	165	210
12		75	105	135	175
13		60	85	110	145
14		50	70	95	120
15		40	60	80	100
16			50	65	85
17			40	50	70
18				45	60

$\frac{3}{4}'' \times 2\frac{3}{16}''$ Bars

Safe Loads in pounds per square foot

Span in feet	Depth of Tile						
	6″	8″	10″	12″			
	16″ o. c.	16″ o. c.	16″ o. c.	16″ o. c.	14″ o. c.	12″ o. c.	10″ o. c.
8	355	495	665				
9	275	390	515	670			
10	225	310	415	540	630	730	
11	185	250	335	440	510	600	720
12	150	210	275	370	420	500	600
13	125	175	235	310	355	420	510
14	105	150	200	260	300	360	430
15	90	125	170	220	260	310	370
16	75	110	145	190	225	270	325
17	65	95	125	170	200	230	290
18	55	80	110	150	175	200	250
19		70	95	130	150	180	220
20		60	85	115	130	160	200
21		55	75	100	120	140	185
22		45	65	90	110	125	160
23		40	55	80	95	110	140
24			50	70	80	100	125
25			45	60	70	90	115
26			40	50	65	80	105
27				45	60	70	95
28				40	50	65	85
29					45	60	80
30					40	55	70



SECTION THROUGH HOLLOW TILE FLOOR.

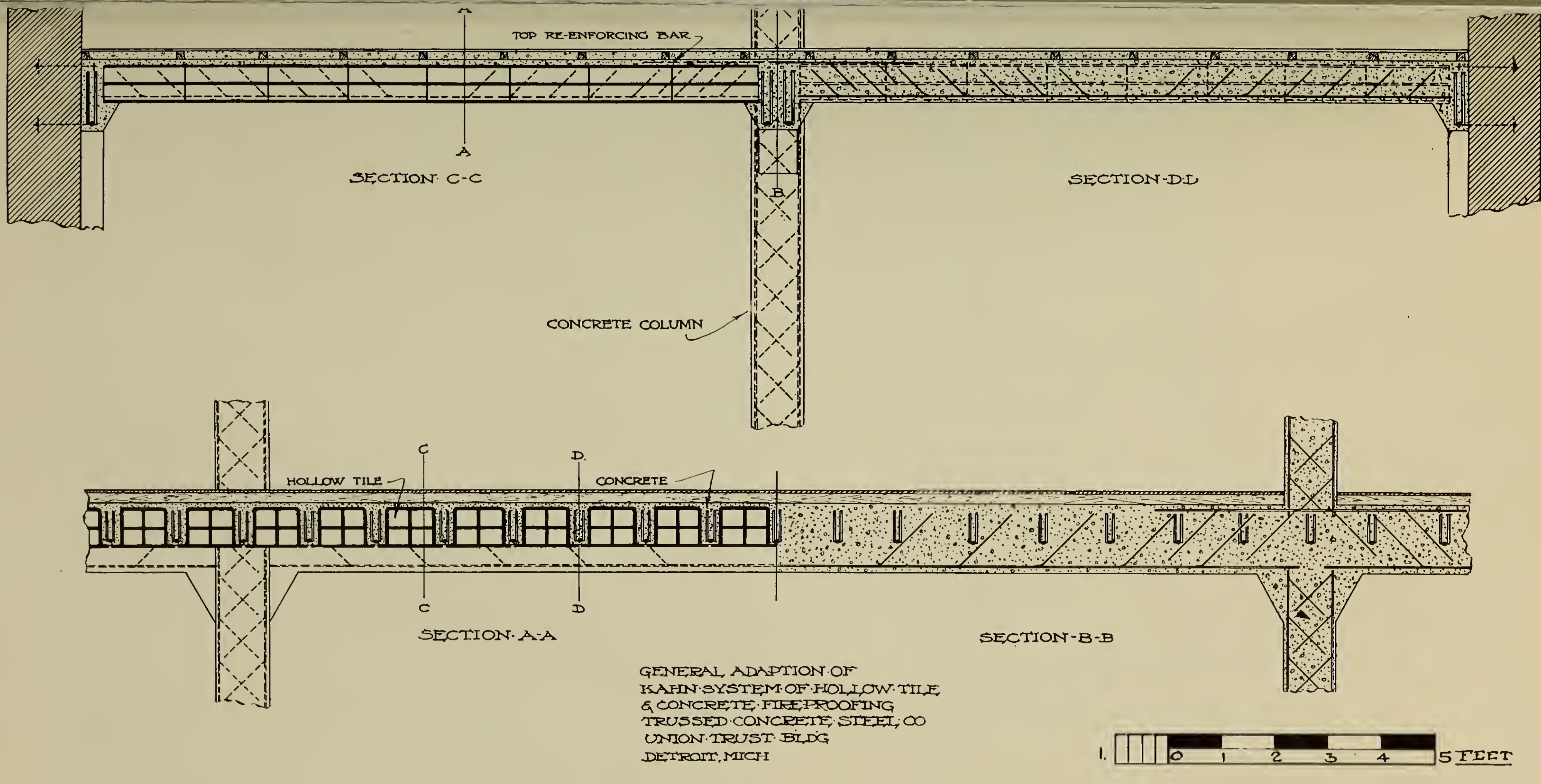

TOP RE-ENFORCING BAR
SECTION C-C
SECTION D-D
CONCRETE COLUMN
HOLLOW TILE
CONCRETE
SECTION A-A
SECTION B-B
GENERAL ADAPTION OF
KAHN SYSTEM OF HOLLOW TILE
& CONCRETE FIREPROOFING
TRUSSED CONCRETE STEEL CO
UNION TRUST BLDG
DETROIT, MICH
1 0 1 2 3 4 5 FEET

Fig. 19.

Centering may be removed with exceptional speed, as the concrete is rich and is placed in the form of joists instead of as a slab. The dead weight of the floor also is very light; in fact, more so than any system in use at the present time. Under ordinary conditions centering may be taken out within a week. For that reason a building is not delayed, since just about as quickly as the mason can lay up the exterior brick walls, the fireproofing contractor can remove his centering and replace it ready for the next floor.

The concrete being placed in the form of vertical joists in place of a flat floor slab, gives remarkably great carrying capacity.

In this system of construction advantage is taken of the lightness of tile, together with the strength of reinforced concrete. Their combination makes the most perfect fireproof floor known to-day for certain purposes.

Sound proof qualities

In hospitals, residences, schools, hotels, etc., it is absolutely essential that the floors be made sound proof. This result is accomplished in the Kahn re-inforced hollow tile construction almost with perfection, as the air spaces in the tile form stops for sound and break up transmission.

Length of span

These may be built up to 30 feet with the same ease of construction as is done for 14 or 16 ft. with the solid concrete slab.

The Trussed Concrete Steel Company constantly builds girders up to 30 and 40 ft. span in reinforced concrete. With their system of tile construction joists of this nature are provided practically every 16″. The advantage of this system to the Architect in preparing his plans, due to the use of long spans, should alone be sufficient reason for its specification.

Practically all intermediate beams are avoided and plans need call for only the necessary supporting walls, and possibly a center line of girders.

Flat ceilings

Individual beams are almost entirely avoided with this system, and in all cases a flat ceiling is provided ready for plastering.

Rigidity of construction

By reason of the fact that the carrying members are reinforced concrete joists 15″ or 16″ on centers, the floor possesses a remarkable rigidity. Deflection under safe loading is practically unknown. In fact the Trussed Concrete Steel Company agrees to test any of its floors to twice their safe carrying capacity without undue deflection.

Footings.

See Fig. 22a. The simplest and most economical footing in existence, requiring less excavation and concrete than any other method, may be obtained

Fig. 20.

Method of laying Kahn System of Reinforced Hollow Tile Construction. Lay tile dry, in rows about 16″ o. c. Then insert one Kahn Trussed Bar in each space between these rows of tile, and fill with 1:2:4 concrete.

Fig. 21.

Kahn System of Reinforced Hollow Tile Construction. Spans shown above are 16′ 0″ clear. Floor is 6″ thick. Note the flat ceiling ready for plaster. Dead weight of tile floor construction 36 lbs. per sq. ft.

Table of Column Footings for column loads varying from 50,000 to 300,000, and bearing values (B) varying from 1,000 to 12,000 lbs. per sq. ft.

B		Column Load										
		50,000	75,000	100,000	125,000	150,000	175,000	200,000	225,000	250,000	275,000	300,000
1000	A	7'3"x7'3"	8'9"x8'9"	10'0"x10'0"	11'3"x11'3"	12'3"x12'3"						
	N	12—½"x1½"	14—½"x1½"	16—½"x1½"	18—½"x1½"	20—½"x1½"						
1500	A	6'0"x6'0"	7'3"x7'3"	8'3"x8'3"	9'3"x9'3"	10'0"x10'0"	11'0"x11'0"	11'9"x11'9"	12'3"x12'3"			
	N	10—½"x1½"	12—½"x1½"	14—½"x1½"	16—½"x1½"	18—½"x1½"	22—½"x1½"	26—½"x1½"	28—½"x1½"			
2000	A	5'0"x5'0"	6'3"x6'3"	7'3"x7'3"	8'0"x8'0"	8'9"x8'9"	9'6"x9'6"	10'0"x10'0"	10'9"x10'9"	11'3"x11'3"	11'9"x11'9"	
	N	8—½"x1½"	10—½"x1½"	14—½"x1½"	16—½"x1½"	18—½"x1½"	22—½"x1½"	24—½"x1½"	28—½"x1½"	16—¾"x2$\frac{3}{16}$"	18—¾"x2$\frac{3}{16}$"	
2500	A	4'6"x4'6"	5'6"x5'6"	6'6"x6'6"	7'3"x7'3"	7'9"x7'9"	8'6"x8'6"	9'0"x9'0"	9'6"x9'6"	10'0"x10'0"	10'6"x10'6"	11'0"x11'0"
	N	8—½"x1½"	10—½"x1½"	14—½"x1½"	18—½"x1½"	20—½"x1½"	24—½"x1½"	14—¾"x2$\frac{3}{16}$"	14—¾"x2$\frac{3}{16}$"	16—¾"x2$\frac{3}{16}$"	18—¾"x2$\frac{3}{16}$"	18—¾"x2$\frac{3}{16}$"
3000	A	4'3"x4'3"	5'0"x5'0"	6'0"x6'0"	6'6"x6'6"	7'3"x7'3"	7'9"x7'9"	8'3"x8'3"	8'9"x8'9"	9'3"x9'3"	9'9"x9'9"	10'0"x10'0"
	N	8—½"x1½"	10—½"x1½"	14—½"x1½"	16—½"x1½"	20—½"x1½"	24—½"x1½"	14—¾"x2$\frac{3}{16}$"	14—¾"x2$\frac{3}{16}$"	16—¾"x2$\frac{3}{16}$"	18—¾"x2$\frac{3}{16}$"	18—¾"x2$\frac{3}{16}$"
4000	A		4'6"x4'6"	5'0"x5'0"	5'9"x5'9"	6'3"x6'3"	6'9"x6'9"	7'3"x7'3"	7'6"x7'6"	8'0"x8'0"	8'6"x8'6"	8'9"x8'9"
	N		12—½"x1½"	12—½"x1½"	16—½"x1½"	20—½"x1½"	12—¾"x2$\frac{3}{16}$"	14—¾"x2$\frac{3}{16}$"	16—¾"x2$\frac{3}{16}$"	16—¾"x2$\frac{3}{16}$"	18—¾"x2$\frac{3}{16}$"	18—¾"x2$\frac{3}{16}$"
5000	A		4'0"x4'0"	4'6"x4'6"	5'0"x5'0"	5'6"x5'6"	6'0"x6'0"	6'6"x6'6"	6'9"x6'9"	7'3"x7'3"	7'6"x7'6"	7'9"x7'9"
	N		12—½"x1½"	14—½"x1½"	16—½"x1½"	10—¾"x2$\frac{3}{16}$"	12—¾"x2$\frac{3}{16}$"	14—¾"x2$\frac{3}{16}$"	14—¾"x2$\frac{3}{16}$"	16—¾"x2$\frac{3}{16}$"	18—¾"x2$\frac{3}{16}$"	20—¾"x2$\frac{3}{16}$"
6000	A			4'3"x4'3"	4'9"x4'9"	5'0"x5'0"	5'6"x5'6"	6'0"x6'0"	6'3"x6'3"	6'6"x6'6"	7'0"x7'0"	7'3"x7'3"
	N			8—¾"x2$\frac{3}{16}$"	10—¾"x2$\frac{3}{16}$"	10—¾"x2$\frac{3}{16}$"	12—¾"x2$\frac{3}{16}$"	14—¾"x2$\frac{3}{16}$"	14—¾"x2$\frac{3}{16}$"	16—¾"x2$\frac{3}{16}$"	12—1"x3"	12—1"x3"
7000	A			4'0"x4'0"	4'3"x4'3"	4'9"x4'9"	5'0"x5'0"	5'6"x5'6"	5'9"x5'9"	6'0"x6'0"	6'6"x6'6"	6'9"x6'9"
	N			8—¾"x2$\frac{3}{16}$"	10—¾"x2$\frac{3}{16}$"	10—¾"x2$\frac{3}{16}$"	12—¾"x2$\frac{3}{16}$"	14—¾"x2$\frac{3}{16}$"	10—1"x3"	10—1"x3"	10—1"x3"	12—1"x3"
8000	A				4'0"x4'0"	4'6"x4'6"	4'9"x4'9"	5'0"x5'0"	5'6"x5'6"	5'9"x5'9"	6'0"x6'0"	6'3"x6'3"
	N				10—¾"x2$\frac{3}{16}$"	12—¾"x2$\frac{3}{16}$"	12—¾"x2$\frac{3}{16}$"	12—¾"x2$\frac{3}{16}$"	10—1"x3"	10—1"x3"	10—1"x3"	12—1"x3"
9000	A					4'3"x4'3"	4'6"x4'6"	4'9"x4'9"	5'0"x5'0"	5'6"x5'6"	5'9"x5'9"	6'0"x6'0"
	N					12—¾"x2$\frac{3}{16}$"	14—¾"x2$\frac{3}{16}$"	14—¾"x2$\frac{3}{16}$"	8—1"x3"	10—1"x3"	12—1"x3"	12—1"x3"
10000	A					4'0"x4'0"	4'3"x4'3"	4'6"x4'6"	4'9"x4'9"	5'0"x5'0"	5'3"x5'3"	5'6"x5'6"
	N					8—1"x3"	8—1"x3"	10—1"x3"	10—1"x3"	10—1"x3"	10—1"x3"	12—1"x3"
11000	A						4'0"x4'0"	4'6"x4'6"	4'9"x4'9"	5'0"x5'0"	5'0"x5'0"	5'3"x5'3"
	N						8—1"x3"	10—1"x3"	10—1"x3"	10—1"x3"	10—1"x3"	12—1"x3"
12000	A							4'3"x4'3"	4'6"x4'6"	4'9"x4'9"	5'0"x5'0"	5'0"x5'0"
	N							10—1"x3"	10—1"x3"	10—1"x3"	10—1"x3"	10—1"x3"

See Fig. 22.

by using the Kahn sheared bar. It is designed on the principle of a cantilever beam. The bars are crossed at right angles, thus distributing the upward pressure equally in all directions.

Where there is an upward pressure in a foundation, it is best resisted by a slab, reinforced as an inverted floor slab, and securely tied by beams to the columns.

On page 40 appears a table giving dimensions of column footings for various conditions.

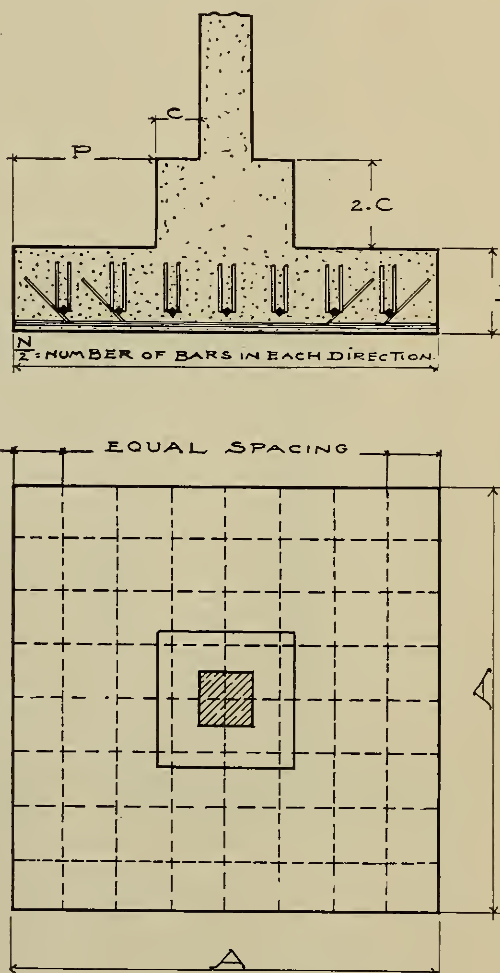


Fig. No. 22a.

Retaining Walls.

Retaining walls of the gravity type afford excellent use for this bar (See Figs. 23, 24). This construction is simply a system of beams, slabs, and buttresses. (See page .. on floor construction). When very high walls are desired, it is often very economical to use an intermediate shelf or slab, see Fig. 23, which construction reduces the problem to smaller walls, one above the other.

The buttresses illustrate another admirable property of this bar, namely, the ability to distribute a pull in a large block of concrete by means of the sheared up members. It is as a result of this principle, *only*, that the entire mass of concrete may be utilized.

This principle and method may also be applied to reservoirs, cisterns, abutments, etc.

Gravity Dams.

Gravity dams, see Fig. 25, offer a method of construction which, if proper reinforcement is used, will be more economical, stronger and safer than the ordinary method. In this construction all slabs, buttresses, and beams, are rigidly connected by inverted reinforcing bars, thus forming, not merely a monolithic structure, but a stiff, strong combination of well balanced members.

The outer shell completely closes the interior with the exception of erection openings. Through these, the interior may be filled with stone, gravel, earth, or any convenient material, thereby forming a practically indestructible

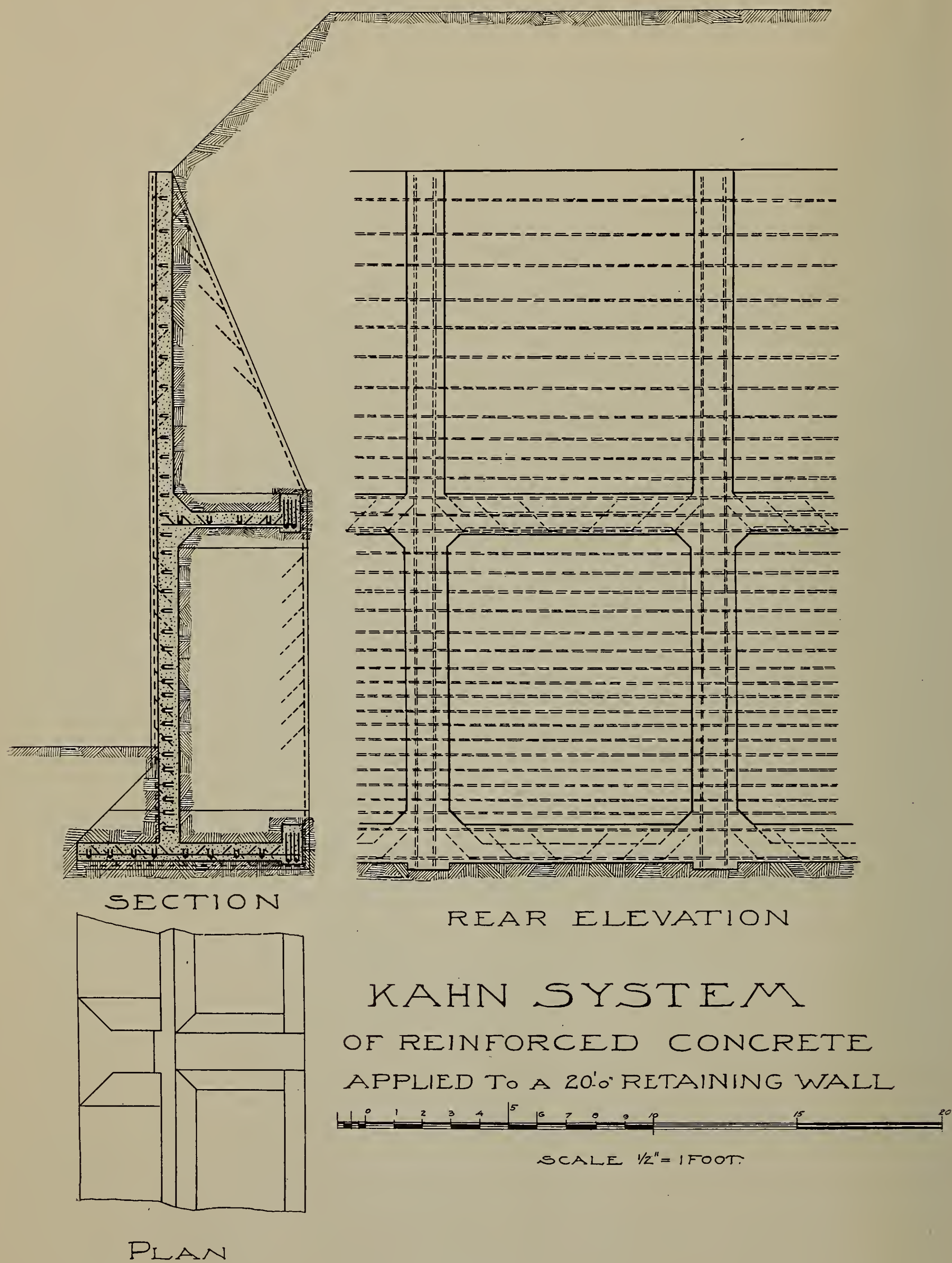

SECTION
REAR ELEVATION
KAHN SYSTEM
OF REINFORCED CONCRETE
APPLIED TO A 20'0" RETAINING WALL
0 1 2 3 4 5 6 7 8 9 10 15 20
SCALE 1/2" = 1 FOOT
PLAN

Fig. 23.

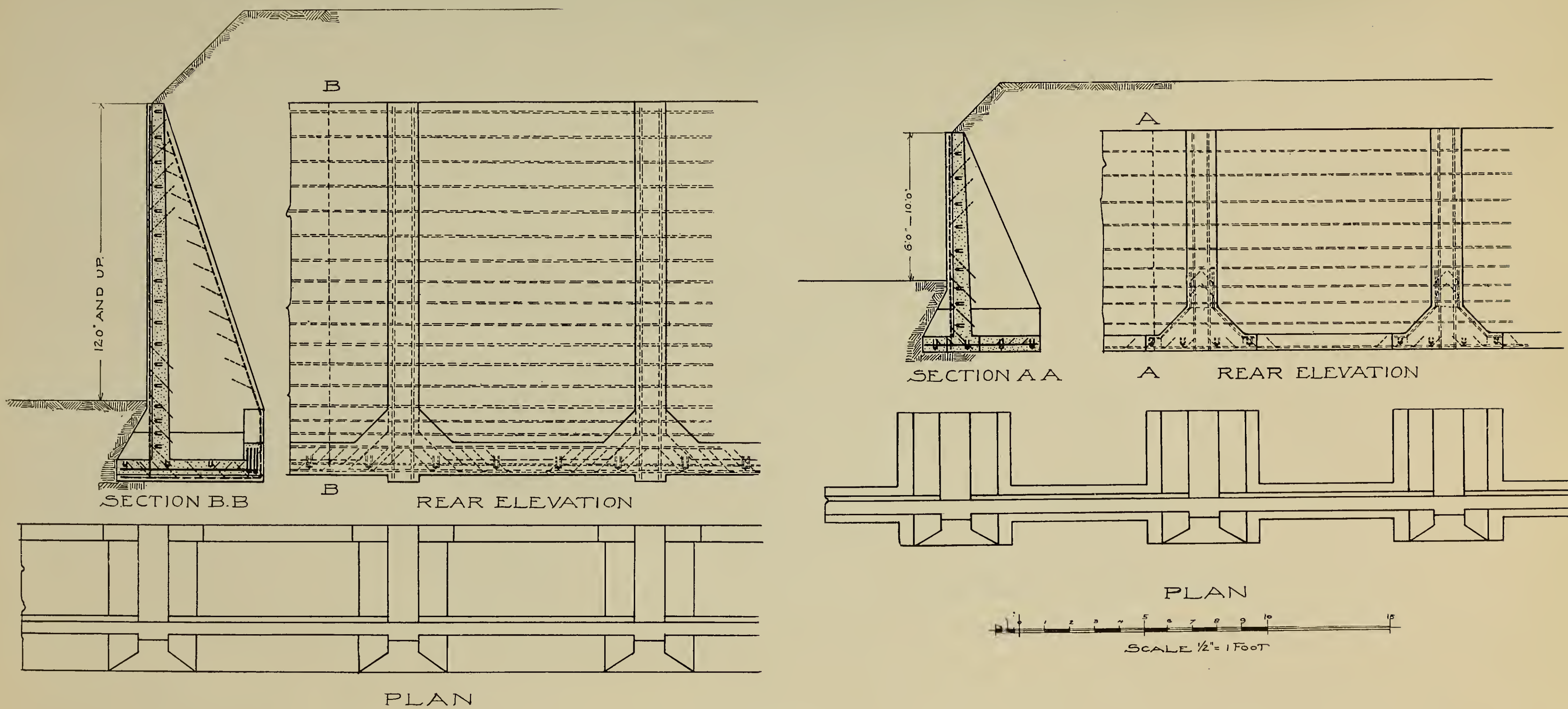


Fig. 24.

Concrete Retaining Walls reinforced with the Kahn Trussed Bars.

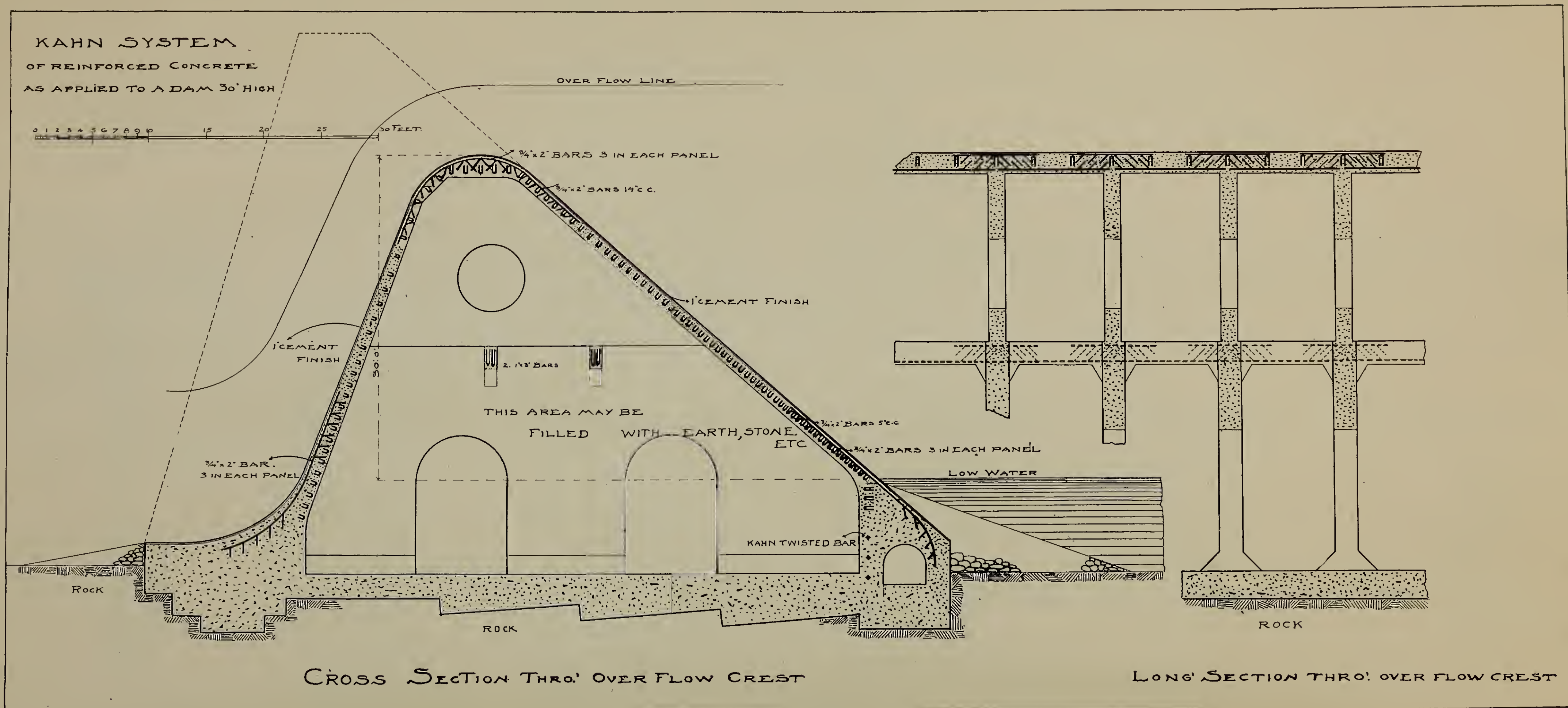

KAHN SYSTEM
OF REINFORCED CONCRETE
AS APPLIED TO A DAM 30' HIGH
30 FEET
OVER FLOW LINE
3/4" x 2" BARS 3 IN EACH PANEL
3/4" x 2" BARS 14" c.c.
1" CEMENT FINISH
1" CEMENT FINISH
2. 1x3" BARS
THIS AREA MAY BE
FILLED WITH EARTH, STONE ETC
3/4" x 2" BARS 5" c.c.
3/4" x 2" BARS 3 IN EACH PANEL
LOW WATER
3/4" x 2" BAR. 3 IN EACH PANEL
KAHN TWISTED BAR
ROCK
ROCK
ROCK
CROSS SECTION THRO.' OVER FLOW CREST
LONG' SECTION THRO.' OVER FLOW CREST

FIG. 25.

and water-tight structure, the strength of which increases with age. Surely this is a revival of the grand old Roman method of building, the chief virtue of which is durability.

Similar constructions may be used for reservoirs, locks, etc.

The field in which the Kahn Trussed Bar may be applied and the variety of circumstances that may surround its application are so extensive that this pamphlet can only attempt to drop a few hints concerning its use. In the majority of cases, however, the simplicity with which the Kahn Trussed Bar lends itself to application is so obvious that any engineer or architect may use it freely with good results. However, in the more difficult and new problems, it would be well to consult the engineers of the Trussed Concrete Steel Company, thereby obtaining suggestions and advice that might be of great value. Their services will be gladly rendered, free of charge.

The arch diagram shown on page 49, together with tables, etc., on pages 48, 49, is an adaptation of Prof. Charles E. Greene's method of calculation for parabolic ribs with fixed ends.

Numerous solutions for concrete steel arches have been deduced, but all more or less impractical and doubtful. The method given is adopted on account of its simplicity. For further description and information regarding this, reference is made to "Trusses and Arches," part 3, by Prof. Charles E. Greene.

Railroad Work.

We desire to emphasize to railroad men some of the properties that the Kahn Trussed bar possesses, and which are of fundamental importance in the design of railroad bridges, culverts, tunnels, etc. The following points will impress all conscientious Engineers that the Kahn system of reinforced concrete is the only true, scientific and complete method that is particularly adapted to railroad construction. :—

1. General rigidity.
2. Great durability, due to permanency of masonry, combined with thorough protection of steel.
3. Provision for moving and concentrated loading.
4. Small initial and maintenance cost.
5. Speed of erection as material is procurable everywhere.
6. Safety of construction. A concrete beam reinforced with the Kahn Trussed bar will deflect as much as 20″ before actual destruction occurs. This acts as a great warning factor against overloading.

Arch.

One of the most beautiful, simple and effective adaptations of the Kahn trussed bar is the arch. The theory of an elastic arch resembles that of a beam in so far that the maximum bending moment occurs where the shear is minimum, and maximum shear where bending moment is a minimum. This regulates the number and position of the diagonal members, and thus the gross area of section is reserved for places of maximum bending moment. The bars need not be joined, as the mere lapping of one or two diagonal members is sufficient to develop the full strength of the bar.

The Kahn sheared bar is the only one which may be placed in the intrados without fearing the tendency of the bar to straighten.

One need but look at the latticed effect, so happily produced here, to be strongly impressed as to the many merits of the Kahn sheared bar. At the crown of the arch, where there is little filling, the effect of concentrated loads can be cared for by cross bars, which act as distributors over the entire width of the arch.

This method of construction may be applied to bridges, culverts, sewers, conduits, tunnels, etc.

See Figs. 26, 28, 29, 37, 48.

Fig. 26.

Parabolic Rib. Fixed at Ends.

M = m. c. W.

Values of "m" at points:

	0	1	2	3	4	5	6	7	8	9	10	H
W. on 9	+.022	+.006	—.005	—.012	—.013	—.010	—.002	+.011	+.028	+.051	—.121	$.061\frac{c}{k}$ W.
" 8	+.064	+.016	—.017	—.035	—.037	—.024	+.004	+.048	+.107	—.018	—.128	$.192\frac{c}{k}$ W.
" 7	+.095	+.019	—.031	—.054	—.050	—.020	+.036	+.119	+.028	—.036	—.073	$.331\frac{c}{k}$ W.
" 6	+.096	+.011	—.040	—.056	—.037	+.016	+.104	+.026	—.017	—.026	0	$.432\frac{c}{k}$ W.
" 5	+.062	—.006	—.037	—.031	+.012	+.094	+.012	—.031	—.037	—.006	+.062	$.469\frac{c}{k}$ W.
" 4	0	—.026	—.017	+.026	+.104	+.016	—.037	—.056	—.040	+.011	+.096	$.432\frac{c}{k}$ W.
" 3	—.073	—.036	+.028	+.119	+.036	—.020	—.050	—.054	—.031	+.019	+.095	$.331\frac{c}{k}$ W.
" 2	—.128	—.018	+.107	+.048	+.004	—.024	—.037	—.035	—.017	+.016	+.064	$.192\frac{c}{k}$ W.
" 1	—.121	+.051	+.028	+.011	—.002	—.010	—.013	—.012	—.005	+.006	+.022	$.061\frac{c}{k}$ W.

M = Bending moment in ft. lbs.
c = $\frac{\text{Span (in feet)}}{2}$
W = Load in lbs.
K = Rise of arch in feet.
H = Horizontal thrust in lbs.
— Indicates tension on top.
+ Indicates tension on bottom.

Method of Calculation and Tables for Parabolic Arches. (Fixed at Springing and Continuous over Crown)

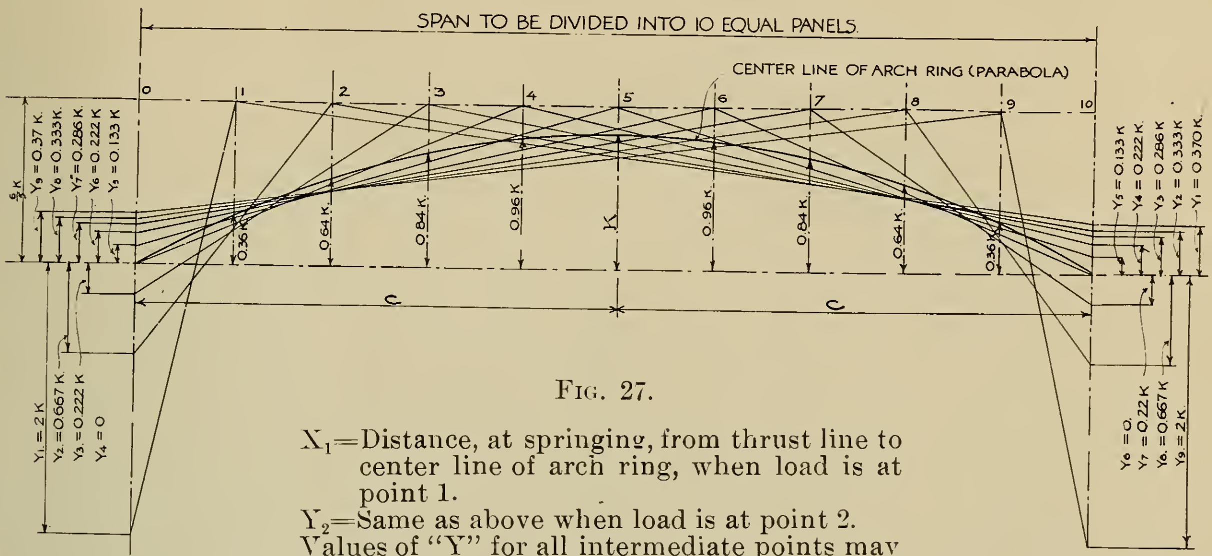


FIG. 27.

X_1=Distance, at springing, from thrust line to center line of arch ring, when load is at point 1.
Y_2=Same as above when load is at point 2.
Values of "Y" for all intermediate points may be computed.

Example Showing Use of Arch Tables.

PROPOSITION.—To find maximum bending moment at point "8" for arch of 50′0″ span, rise = $\frac{1}{7}$ span.

Assume dead load equivalent to earth load (with horizontal surface) 3′0″ deep at crown and at 100 lbs. per cubic foot.

Live load = 300 lbs. per square foot.

Assume loading to act as concentrated at panel points indicated.

SOLUTION.—The loadings for max. moments at point "8" are (see table):
For max. + moment = dead load on all points + live load on 7, 8 and 9.
For max. − moment = dead load on all points + live load 1, 2, 3, 4, 5 and 6.
Loading for max. horizontal thrust is dead and live loads on all points.

Point.	Max. + Moment at "8"					Max. — Moment at "8"			Max. Horizontal Thrust.			
	"m" from table.	c	W	M=m c W +	M=m c W −	W	M=m c W +	M=m c W −	"H" See table	$\frac{c}{k}$	W	$H=\frac{h\ c\ W}{k}$
9	+.028	25	5300	3700		3800	2700		.061	3.5	5300	1130
8	+.107	25	4300	11500		2800	7500		.192	3.5	4300	2890
7	+.028	25	3600	2500		2100	1500		.331	3.5	3600	4180
6	−.017	25	1650		700	3150		1350	.432	3.5	3150	4760
5	−.037	25	1500		1400	3000		2800	.469	3.5	3000	4920
4	−.040	25	1650		1650	3150		3150	.432	3.5	3150	4760
3	−.031	25	2100		1600	3600		2800	.331	3.5	3600	4180
2	−.017	25	2800		1200	4300		1850	.192	3.5	4300	2890
1	−.005	25	3800		500	5300		700	.061	3.5	5300	1130
	Total, . .		. . .	17700	7050		11700	12650				30840

Max. + moment = 17700 − 7050 = + 10650 ft. lbs.
Max. − moment = 11700 − 12650 = − 950 ft. lbs.

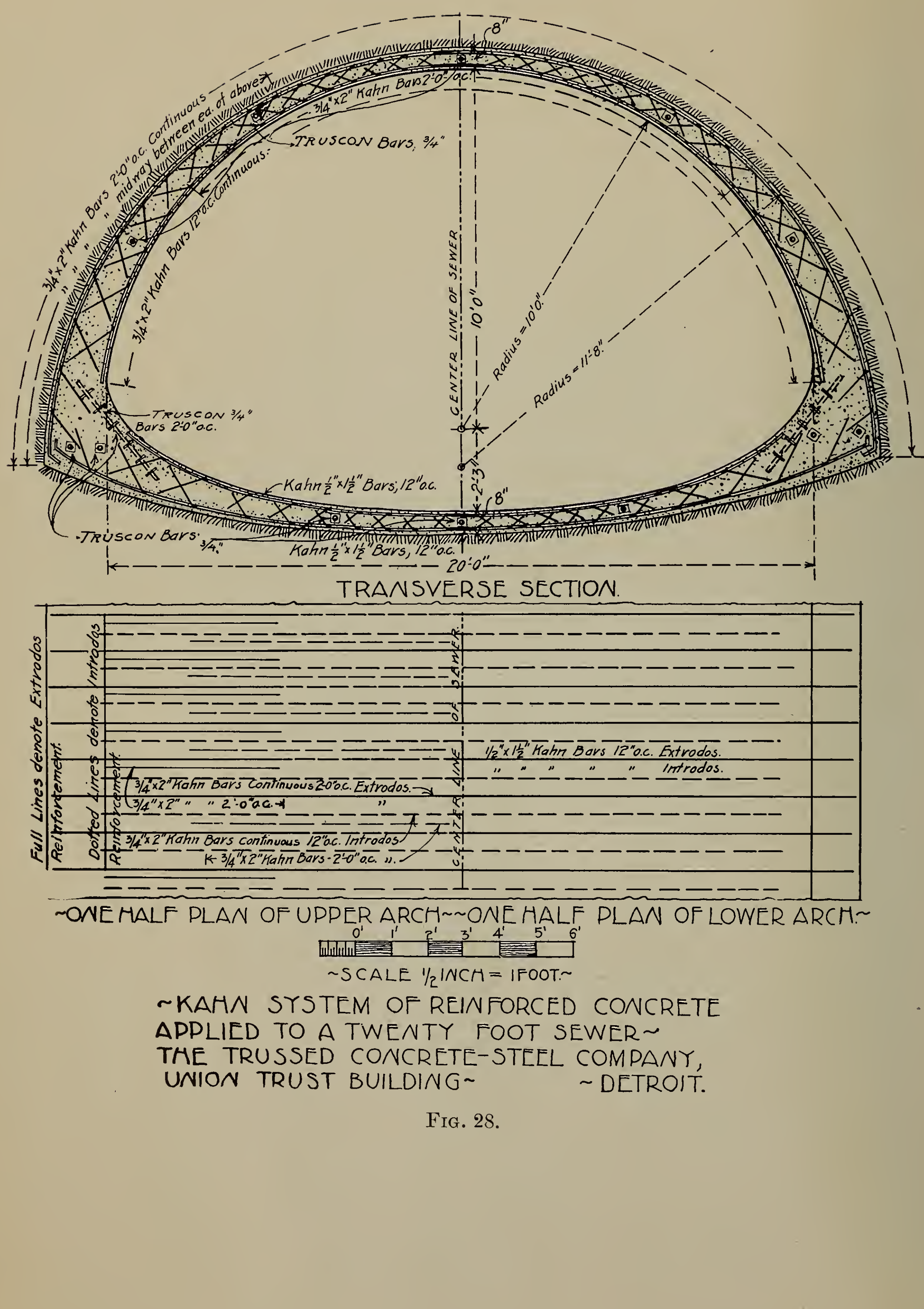

3/4"x2" Kahn Bars 2'-0" o.c. Continuous
" " " " midway between ea. of above
3/4"x2" Kahn Bars 2'-0" o.c.
TRUSCON Bars, 3/4"
3/4"x2" Kahn Bars 12" o.c. Continuous
TRUSCON 3/4" Bars 2'-0" o.c.
CENTER LINE OF SEWER
10'0"
Radius = 10'0"
Radius = 11'8"
8"
2'-3"
Kahn 1/2"x1 1/2" Bars; 12" o.c.
TRUSCON Bars 3/4"
Kahn 1/2"x1 1/2" Bars, 12" o.c.
20'-0"
TRANSVERSE SECTION.
Full Lines denote Extrodos Reinforcement.
Dotted Lines denote Introdos Reinforcement.
CENTER LINE OF SEWER
1/2"x1 1/2" Kahn Bars 12" o.c. Extrodos.
" " " " " Introdos.
3/4"x2" Kahn Bars Continuous 2'-0" o.c. Extrodos.
3/4"x2" " " 2'-0" o.c.
3/4"x2" Kahn Bars continuous 12" o.c. Introdos
3/4"x2" Kahn Bars-2'-0" o.c. "
~ONE HALF PLAN OF UPPER ARCH~~ONE HALF PLAN OF LOWER ARCH~
0' 1' 2' 3' 4' 5' 6'
~SCALE 1/2 INCH = 1 FOOT~
~KAHN SYSTEM OF REINFORCED CONCRETE
APPLIED TO A TWENTY FOOT SEWER~
THE TRUSSED CONCRETE-STEEL COMPANY,
UNION TRUST BUILDING~ ~DETROIT.

Fig. 28.

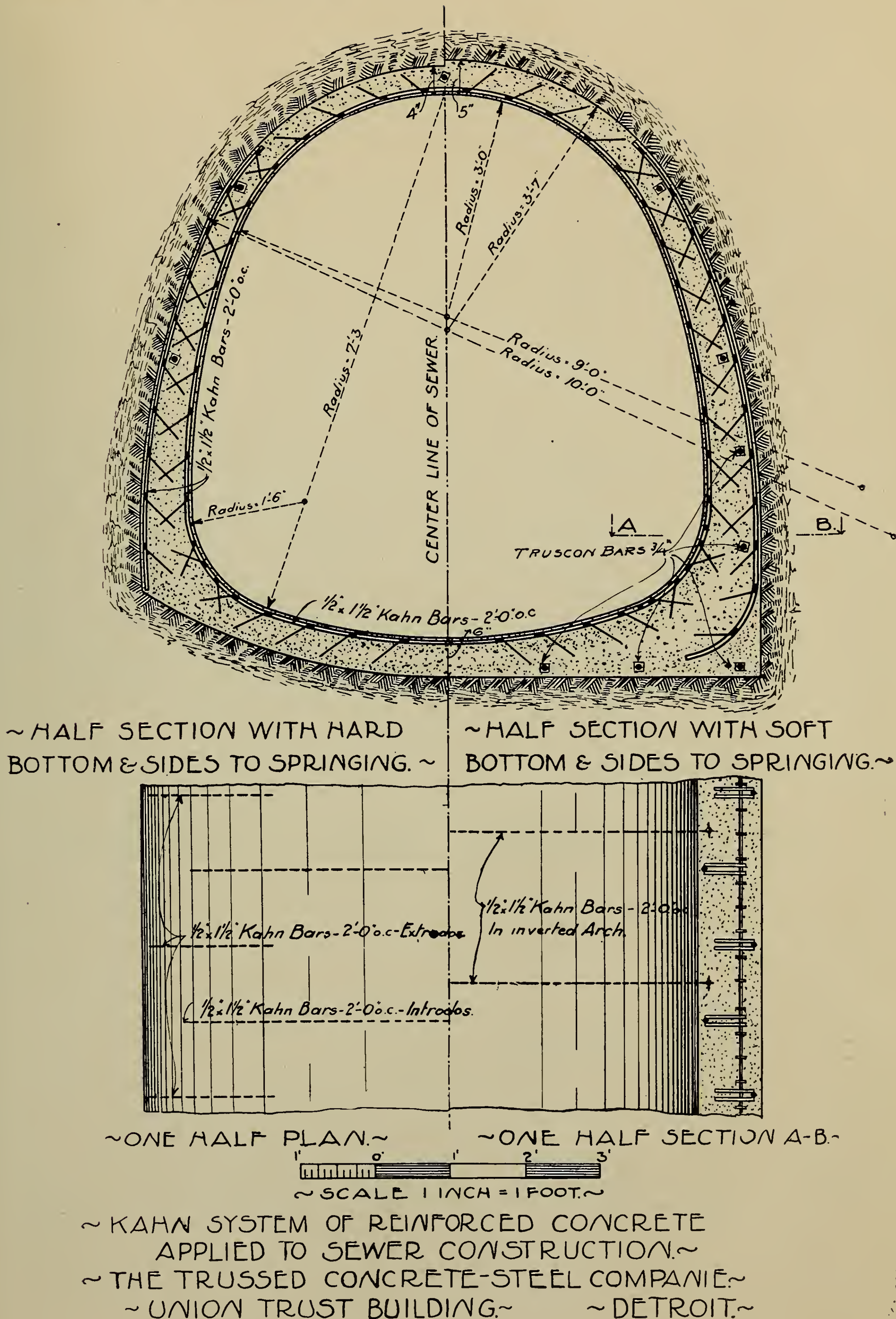

4"
5"
Radius - 3'-0"
Radius - 3'-7"
Radius - 9'-0"
Radius - 10'-0"
Radius - 2'-3"
CENTER LINE OF SEWER
1/2 x 1 1/2 Kahn Bars - 2'-0" o.c.
Radius - 1'-6"
A
B
TRUSCON BARS 3/4"
1/2 x 1 1/2 Kahn Bars - 2'-0" o.c.
~HALF SECTION WITH HARD BOTTOM & SIDES TO SPRINGING.~
~HALF SECTION WITH SOFT BOTTOM & SIDES TO SPRINGING.~
1/2 x 1 1/2 Kahn Bars - 2'-0" o.c. In inverted Arch.
1/2 x 1 1/2 Kahn Bars - 2'-0" o.c.-Extrados.
1/2 x 1 1/2 Kahn Bars - 2'-0" o.c.-Intrados.
~ONE HALF PLAN.~
~ONE HALF SECTION A-B.~
1' 0' 1' 2' 3'
~SCALE 1 INCH = 1 FOOT.~
~KAHN SYSTEM OF REINFORCED CONCRETE APPLIED TO SEWER CONSTRUCTION.~
~THE TRUSSED CONCRETE-STEEL COMPANIE~
~UNION TRUST BUILDING.~ ~DETROIT.~

Fig. 29.

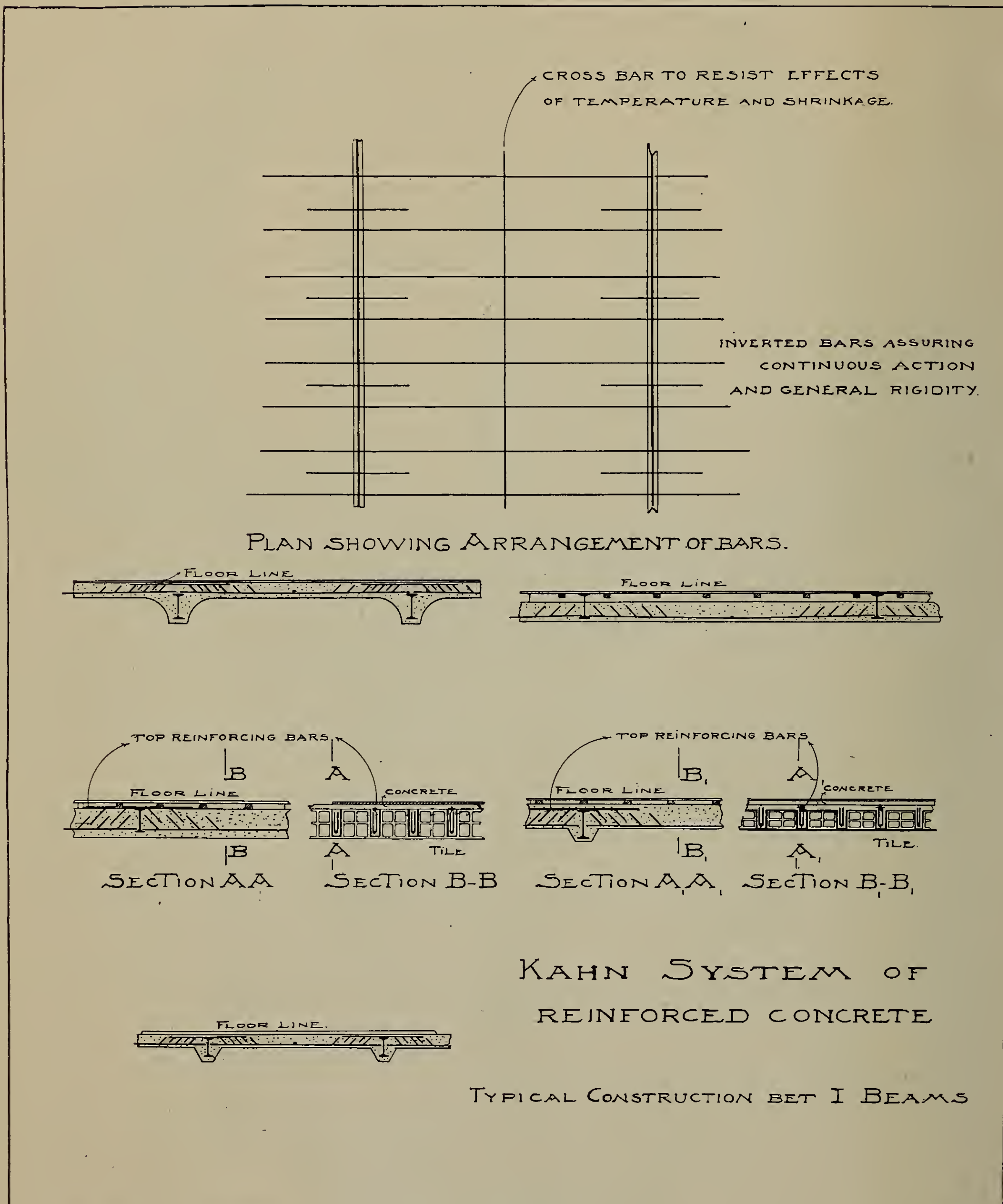

CROSS BAR TO RESIST EFFECTS OF TEMPERATURE AND SHRINKAGE.
INVERTED BARS ASSURING CONTINUOUS ACTION AND GENERAL RIGIDITY.
PLAN SHOWING ARRANGEMENT OF BARS.
FLOOR LINE
FLOOR LINE
TOP REINFORCING BARS
FLOOR LINE
CONCRETE
TILE
SECTION AA
SECTION B-B
TOP REINFORCING BARS
FLOOR LINE
CONCRETE
TILE
SECTION A,A,
SECTION B,B,
KAHN SYSTEM OF REINFORCED CONCRETE
FLOOR LINE.
TYPICAL CONSTRUCTION BET I BEAMS

Fig. 30.

Tables

General Description

In these tables it is assumed that floors have been constructed in accordance with the Kahn System of Reinforcement, as illustrated in our catalogue, and that bars have been inverted in their position over supports to procure the effects of continuous beam action.

2. Concrete to be composed of the best grade of Portland Cement, sharp, clean sand and broken stone or gravel, in the proportions of 1 :2½ :5 for floor slabs, and 1 :2 :4 for beams. Broken stone or gravel a 1″ ring.

3. Bars to be placed at least ¾″ from the bottom of the beam, and the concrete thoroughly rammed in place.

4. Centering not to be removed in less than two and one-half weeks, if the concrete has not been subjected to frost. If freezing has occurred, centering must not be removed until every indication of frost is removed, and the concrete thoroughly set.

Tables were calculated for a factor of safety of 4. However, when this system is incorporated into a combination of continuous beams, the resultant factor of safety rises to 6 or 7. This is due to arch action, tension in concrete, continuity, and slab action, as well as numerous other facts which, on account of the difficulty attending their exact calculation, it is deemed advisable to neglect in these tables.

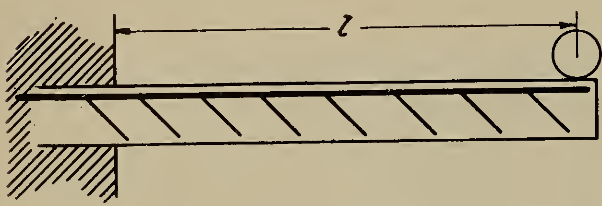
The following are the usual assumptions made in practice for superimposed loads:

Floors of dwellings and offices	70	lbs. per sq. ft.
Floors of churches, theaters, and ball rooms	250	" " " "
Floors of warehouses	200 to 250	" " " "
Floors for heavy machinery	250 to 400	" " " "

Bending moments of Beams under various Systems of Loading

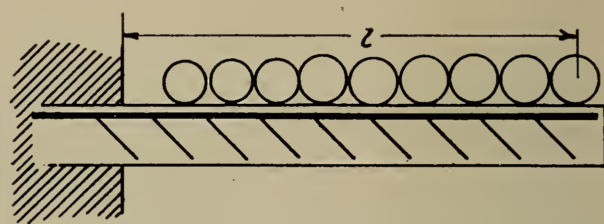
W=total load. l=length of beam.

(1) Beam fixed at one end and loaded at the other.



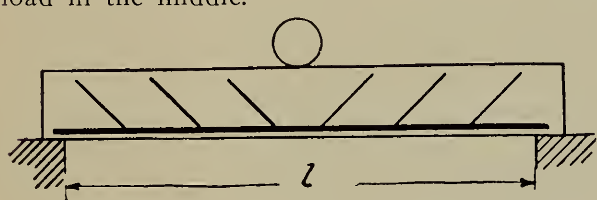
Safe load=$\frac{1}{8}$ that given in tables, pages 36 and 37.
Maximum bending moment at point of support=Wl.
Maximum shear at point of support=W.

(2) Beam fixed at one end and uniformly loaded.



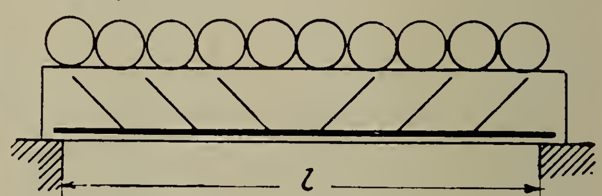
Safe load=$\frac{1}{4}$ that given in tables, pages 36 and 37.
Maximum bending moment at point of support=$\frac{1}{2}$ Wl.
Maximum shear at point of support=W.

(3) Beam supported at both ends, single load in the middle.



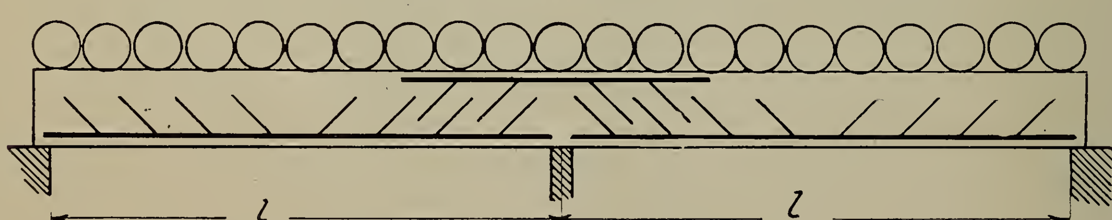
Safe load=$\frac{1}{2}$ that given in tables, pages 36 and 37.
Maximum bending moment at middle of beam=$\frac{1}{4}$ Wl.
Maximum shear at points of support= $\frac{1}{2}$ W.

(4) Beams supported at both ends and uniformly loaded.



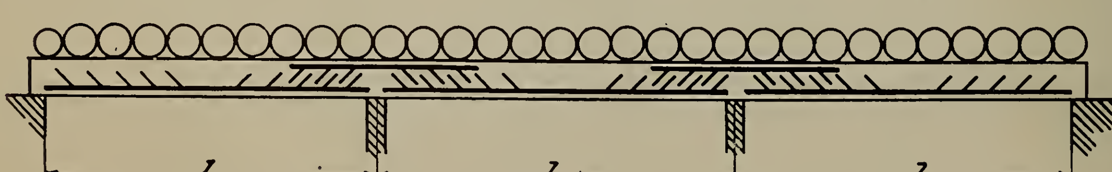
Safe load=that given in tables, pages 36 and 37.
Maximum bending moment at middle of beam=$\frac{1}{8}$ Wl.
Maximum shear at points of support=$\frac{1}{2}$ W.

(5) Continuous beam supported at three points and uniformly loaded.



Safe load=that given in tables, pages 36 and 37.
Maximum bending moment at center pier=$\frac{1}{8}$ Wl.
Maximum shear at center support=$\frac{5}{8}$ W.

(6) Continuous beam supported at four points and uniformly loaded.

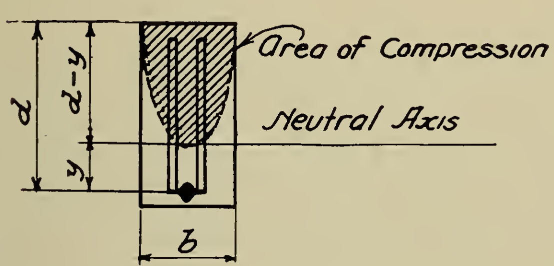


Safe load=$\frac{5}{4}$ that given in tables, pages 36 and 37.
Maximum bending moment at interior piers=$\frac{1}{10}$ Wl.
Maximum shear=$\frac{6}{10}$ W.

Reinforced Concrete

Formulae for the use of Reinforced Concrete

To locate the neutral axis of a reinforced concrete beam, it is supposed that the same is an elastic structure, in which both materials yield under a strain in the inverse ratio of their modulæ of elasticity. Since the modulus for steel is about 30,000,000, and that of concrete 2,000,000, their ratio is approximately fifteen, and a beam would deflect in the same manner if the steel were replaced by a strip of concrete of equal depth, but with an area fifteen times as great. For such a beam the neutral axis would correspond to the center of gravity of the increased section. Having established the neutral axis, the total moment of resistance equals the combined moment of the steel in tension and the concrete in comparison, about the neutral axis.



E_s=modulus of elasticity of steel=30,000,000.

E_c=modulus of elasticity of concrete=2,000,000.

F =ultimate tensile strength of steel=64,000.

f_t=ultimate tensile strength of concrete=200.

f_d=ultimate compressive strength of concrete =3,000.

a =area of metal.

$$y=\frac{15a+bd^2}{30a+2bd}$$

$$\text{Ultimate bending moment}=\text{Moment of Resistance}=\left\{\tfrac{7}{8}(d-y)+y\right\}aF+\frac{f_t\,by^2}{3}$$

If tensile strength of concrete is disregarded,

$$\text{Ultimate B.M.}=\text{M.R.}=\left\{\tfrac{7}{8}(d-y)+y\right\}aF.$$

For safe loading, assume one-fourth or one-fifth of above values.
Note—Breadth of beam=b, should never be less than $\frac{aF}{1800\,(d-y)}$.

Where a floor slab rests upon a beam and forms a part of it, it seems entirely reasonable to assume that the lever arm for the moment of resistance is equal to the distance between the center of gravity of the metal and the center of the floor slab. In such cases, the steel reinforcement in the slab should be reversed over the place of support to take care of the negative bending moment existing there. In the tables given for floor slabs, it has been assumed that the bending moment has been reduced from 1-8 Wl to 1-10 Wl, and results are thus proportioned.

Column Formulae

Carrying capacity where length of column does not exceed fifteen times the least diameter.

Safe load=$400(A_c+15A_s)$. A_c =area of concrete. A_s =area of steel reinforcement.

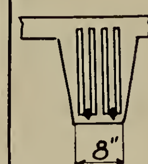
In this construction it is absolutely essential that the prongs are bent at 45° with the main member, that they extend entirely across the column, and that the concrete is tamped in sections not exceeding 12 inches to insure absence of voids.

Safe loads in hundreds of pounds uniformly distributed for concrete beams reinforced with Kahn Trussed Bars

Safe Loads below are figured for fibre stress in steel of 16000 lbs. per square inch.

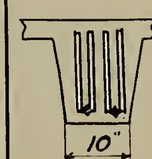
If beams are made continuous across supports by inverting reinforcement bars, safe loads may be increased by ¼

D	Distance between center of supports in feet																					
	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
6	40	35	32	29	27	25	23	21	20	19	18	17	16										
8	56	50	45	41	38	35	32	30	28	27	25	24	23	21	20								
10	74	66	59	53	49	45	42	40	37	35	33	31	30	28	27	26	25	24	23				
12	93	82	74	67	62	57	53	50	46	44	41	39	37	35	34	32	31	30	28	27			
14	110	98	88	80	73	68	63	59	55	52	49	46	44	42	40	38	37	35	34	33	31		
16	123	110	98	89	82	75	70	65	61	58	55	52	49	47	45	43	41	39	38	36	35	34	
18	138	122	110	100	92	85	79	73	69	65	61	58	55	52	50	48	46	44	42	41	39	38	37
20	154	137	123	113	102	95	88	82	77	72	68	65	61	58	56	54	51	49	47	46	44	42	41



$\frac{1}{2}$"x$1\frac{1}{2}$" Bars
A=.76 sq. in.
W=2.8 lbs.
L=6"

D	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
8	110	98	88	80	73	68	63	59	55	52	49	46	44	42	40	38	37	35	34	33	31		
10	147	130	117	106	98	90	84	78	73	69	65	62	59	56	53	51	49	47	45	43	42	40	
12	190	169	152	138	127	117	108	101	95	90	85	80	76	72	69	66	63	61	58	56	54	52	51
14	210	188	169	154	141	130	121	113	106	99	94	89	85	81	77	74	71	68	65	63	60	58	56
16	248	220	198	180	165	152	142	132	124	117	110	104	99	94	90	86	82	79	76	73	71	68	66
18	280	249	224	203	186	172	160	149	140	132	124	118	112	107	102	97	93	90	86	83	80	77	75
20	314	279	251	228	209	193	179	168	157	148	139	132	125	120	114	109	105	100	97	93	90	87	84
22	347	309	278	252	232	214	198	185	174	163	154	146	139	132	126	121	116	111	107	103	99	96	93



$\frac{3}{4}$"x$2\frac{3}{16}$" Bars
A=1.56 sq. in.
W=5.4 lbs.
L=12"

A—Area of steel in sq. in. W—Weight of steel per linear foot L—Length of diagonals

Batter of sides of beams should not be less than 1 : 6 for beams up to 12 inches in depth.

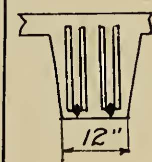
Beams more than 12 inches deep may have vertical sides

D—Depth of beam, in inches, from top of slab to center of steel reinforcement.

Safe loads in hundreds of pounds uniformly distributed for concrete beams reinforced with Kahn Trussed Bars

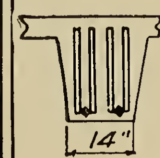
Safe Loads below are figured for fibre stress in steel of 16000 lbs. per square inch.
If beams are made continuous across supports by inverting reinforcement bars, safe loads may be increased by ¼

D	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	Distance between center of supports in feet																						
10	244	217	195	177	163	150	140	130	122	115	108	103	98	93	89	85	81	78	75	72	70	68	65
12	328	290	261	237	218	200	186	174	163	153	145	137	130	124	118	113	107	104	100	97	93	90	87
14	394	350	315	286	263	242	225	210	197	185	175	166	157	150	143	137	131	126	121	117	112	108	105
16	448	400	358	326	298	276	256	239	224	211	199	188	179	170	163	155	149	143	138	132	128	123	119
18	508	452	406	369	338	312	290	270	254	239	226	214	203	193	184	176	169	162	156	150	145	140	135
20	568	504	453	412	378	348	324	302	283	266	252	238	226	216	206	197	189	181	174	168	162	156	151
22	634	564	507	461	423	390	362	338	317	298	281	266	254	242	230	220	211	203	195	186	182	175	169
24	680	605	544	395	455	418	388	362	340	320	302	286	272	259	247	236	226	217	209	201	194	188	181



1"x3" Bars
A=2.84 sq. in
W=9.6 lbs.
L=12" & 18"

D	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
12	452	402	361	328	300	277	258	240	226	212	200	190	182	172	164	157	150	144	139	134	129	125	121
14	540	480	432	392	360	332	308	288	270	254	240	227	216	206	196	188	180	173	166	160	154	149	144
16	625	555	499	455	416	382	357	333	312	294	277	263	250	238	227	217	208	200	192	185	178	172	167
18	707	630	566	515	472	435	405	377	352	333	314	298	283	270	257	246	236	226	218	210	202	195	188
20	788	700	630	572	525	485	450	420	394	370	350	331	315	300	286	273	262	252	242	233	225	217	210
22	867	770	694	630	577	535	495	462	434	407	386	365	346	330	315	302	289	278	267	257	248	239	231
24	960	854	768	700	640	590	550	512	480	452	427	404	382	366	349	334	320	307	295	284	276	265	256
26	1040	925	832	757	695	640	595	555	520	490	462	438	415	396	378	361	346	333	320	308	297	287	277
28	1125	1000	900	820	750	692	642	600	563	530	500	474	450	428	410	392	375	360	346	334	321	310	300
30	1210	1075	968	878	805	744	680	645	605	568	536	508	483	460	440	420	404	387	372	358	345	333	321



$1\frac{1}{4}$"x$3\frac{3}{4}$" Bars
A=4.0 sq. in.
W=13.8 lbs.
L=18"

A—Area of steel in sq. in. W—Weight of steel per linear foot L—Length of diagonals
Batter of sides of beams should not be less than 1 : 6 for beams up to 16 inches in depth.
Beams more than 16 inches deep may have vertical sides
D—Depth of beam, in inches, from top of slab to center of steel reinforcement.

Spacing of bars in Kahn Reinforced Floors for various uniform loads

½"x1½" Bars   Area .38 sq. in.

Slab	Safe live loads per square foot	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		Distance between center of supports in feet																		
6" Floor Slab	100										18	15	13½	12						
	125									17	14½	12	11	10						
	150								17	14	12	10	9	8						
	175							17	14	12	10	8½	8	7						
	200							15	12½	10½	9	7½	6½	6						
	250						15	12	10	8½	7	6	5½	5						
	300					16	12	10	8	7	6	5								
	350				17	13½	10½	8½	7	6	5									
	400				15	12	9	7½	6	5										
5" Floor Slab	100									16½	14	12	10½							
	125								16	13½	11½	9½	8½							
	150							16	13	11	9	8	7½							
	175						16½	13½	11	9½	8	7	6							
	200						14½	12	10	8	7	6	5							
	250					15	11½	9½	8	6½	5½									
	300				16	13	9½	8	6½	5½										
	350				14	11	8	6½	5½											
	400			16½	12	9½	7½	6	5											

Spacing above is given in inches.

Spacing of bars in Kahn Reinforced Floors for various uniform loads

½″x1½″ Bars   Area .38 sq. in.

	Safe live loads per square foot	Distance between center of supports in feet																		
		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
4″ Floor Slab	100								15	13	11									
	125							16	12	10	9									
	150						15	12	10	8	7									
	175					16½	13	10½	8½	7½	6½									
	200					14½	11½	9	7½	6½	5									
	250				15	11½	9	8	6	5										
	300				13	9½	7½	6	5											
	350			15	11	8	6½	5												
	400			13	9½	7	6													
3″ Floor Slab	100								11½											
	125							11	9											
	150						11	9	7½											
	175						10	8	6½											
	200					11½	8½	7	5½											
	250				11	9	6½	5½												
	300				9	7½	6													
	350			10	8	6½	5													

Spacing above is given in inches.

Spacing of bars in Kahn Reinforced Floors for various uniform loads

$\frac{3}{4}$"x2" Bars Area=.78 sq. in.

	Safe live loads per square foot	Distance between supports in feet																					
		10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
6" Floor Slab	100									19	17	15½	14										
	125								16½	15	13½	12½	11½										
	150						18½	16	14	12½	11½												
	175					18	15½	13½	12	11	9½												
	200				18	15½	13½	12	10½	9½	8½												
	250			17	14½	12½	11	9½	8	7½													
	300		17	14	12	10½	9	8	7	6													
	350	17½	14½	12½	10½	9	7½	6½	6														
	400	15½	12½	10½	9	8	7	6															
5" Floor Slab	100								18½														
	125						18½	17	15														
	150					18	15	14	12½														
	175				17½	15½	13½	12	10½														
	200			18½	15½	13½	12	10½															
	250		17½	15	12½	11	9½	8½															
	300	17½	14½	12	10	9	8																
	350	15	12½	11½	8½	7½	6½																
	400	13	11	9	8	7	6																

Spacing above is given in inches.

Examples showing the use of Tables

Let it be required to construct a floor panel 15 ft. x 18 ft., to carry a total live load of 125 lbs. per square foot. It will be best to have the floor bars extend across the shorter spans 15 feet. Refer to tables on spacing of bars, using ½"x1½" bars. For a 6" floor slab, these bars should be spaced 11 inches on centres; for a 5" floor slab, 8½ inches on centres. Or the heavier bars ¾"x2¼" may be used, spaced 18½ inches on centres, with 5" thickness of floor slab.

The main carrying beams will be those of 18 feet span. The load thereon will be 18x15x125=33.750lbs.=337.5 cwt., plus the dead load of the floor slab (since the dead load of the floor slab becomes the live load on the beam) This dead load being assumed at 140 lbs. per cu. ft. By referring to the tables on safe live loads for beams, a beam carrying this load can quickly be found.

Specifications for Reinforced Concrete

The work called for under these specifications, consists of..............
....
....

It is desired to have the work executed entirely in reinforced concrete, without the use of steel beams in any way.

No system of construction will be considered that does not provide for shearing stresses at the ends of girders and beams.

All floors will be made sufficiently strong to carry their own weight, and a superimposed load of..............lbs. Ceilings to carry............ lbs., roof............... lbs. The load per sq. ft. will include whatever floor finish is used on top of concrete construction.

Right is reserved to test any unit area of the floor construction to failure. If it fails under a superimposed load of less than four times the above amounts per sq. ft. for the respective floors, over the entire area tested, the damage must be made good, and all work must be strengthened so as to meet the requirements of these specifications, without expense to the owner.

Wherever spans exceed 16 ft., reinforced concrete beams shall be used. These must be in accordance with an approved system of construction, and must provide, not only for bending moment, but also for shear, by being reinforced in the vertical plane as well as in the horizontal. These shear members must make an angle with the horizontal member, preferably 45 degrees, and must be rigidly connected to the main horizontal tension bar, similarly to the Kahn system. The adhesion of concrete to steel, in providing for shear, will not be assumed at more than 50 lbs. per sq. in. Vertical reinforcement must, therefore, be sufficiently strong to provide for the internal strains for which concrete is not calculated.

The reinforcing metal must be protected from fire by at least one inch of concrete, measured from the lower surface of the slab to the nearest point of the metal. The metal in girders and beams must be protected by a minimum thickness of 1½″ of concrete.

All concrete must be composed of an approved quality of Portland cement, sand, and broken stone, or gravel. If gravel is used, it must be clean and vary

in size from that of a pea to one inch. The broken stone must be free from fine dust, and broken to pass a 1″ screen.

The concrete for floor slabs must be of a proportion as 1 :2½ :5, of cement, sand, and broken stone. For beams, 1 :2 :4.

Concrete shall generally be placed in the work in layers not exceeding six inches in thickness, and, in general, one layer shall be entirely completed before another is commenced. If delivered by wheel barrows, it shall be dumped as closely as possible to where it is needed, in order to avoid re-handling or excavating while in the mold. Each layer must be thoroughly rammed until the moisture comes to the surface.

All concrete to be mixed by one of the approved standard batch machine mixers. The resultant mixture of sand, cement, and stone, to be as nearly as possible uniform in character, mortar being equally distributed throughout the mass of stone.

The mixture shall be made of such consistency, that when thoroughly rammed, it will quake slightly; but it shall not, in general, be thin enough to quake in the barrow or before ramming. In order that girder or beam molds be well filled, mix the concrete into a more plastic state.

Each bidder must submit general sketches showing his system of reinforced concrete, and the method proposed for applying it to the work in hand, the general location of beams, thickness of floor slabs, etc. He must state what is the quality of his steel bars as to tensile strength, elastic limit, elongation, etc. In no case must the steel be inferior to the standard structural material with an ultimate strength of from 55,000 to 60,000 lbs. per square inch, as recently adopted by the Association of Steel Manufacturers.

The successful bidder will be required to furnish detail working drawings, and specifications, which must be approved by the architect before work is commenced. The centering must be strong enough to hold the plastic concrete true to line, level, and shape.

If at any time during the progress of the work, any concrete is improperly mixed or proportioned, the architect shall have the power to condemn it at once, and prevent its incorporation in the work.

Concrete work will be suspended whenever, in the judgment of the architect, it is liable to injury from freezing.

Steel bars for use in the concrete will not be painted. A slight film of red rust will not be objectionable, but any bar on which rust scales have begun to form will be rejected.

No bid will be considered, except from persons or firms with recent and extensive experience in the form of work called for.

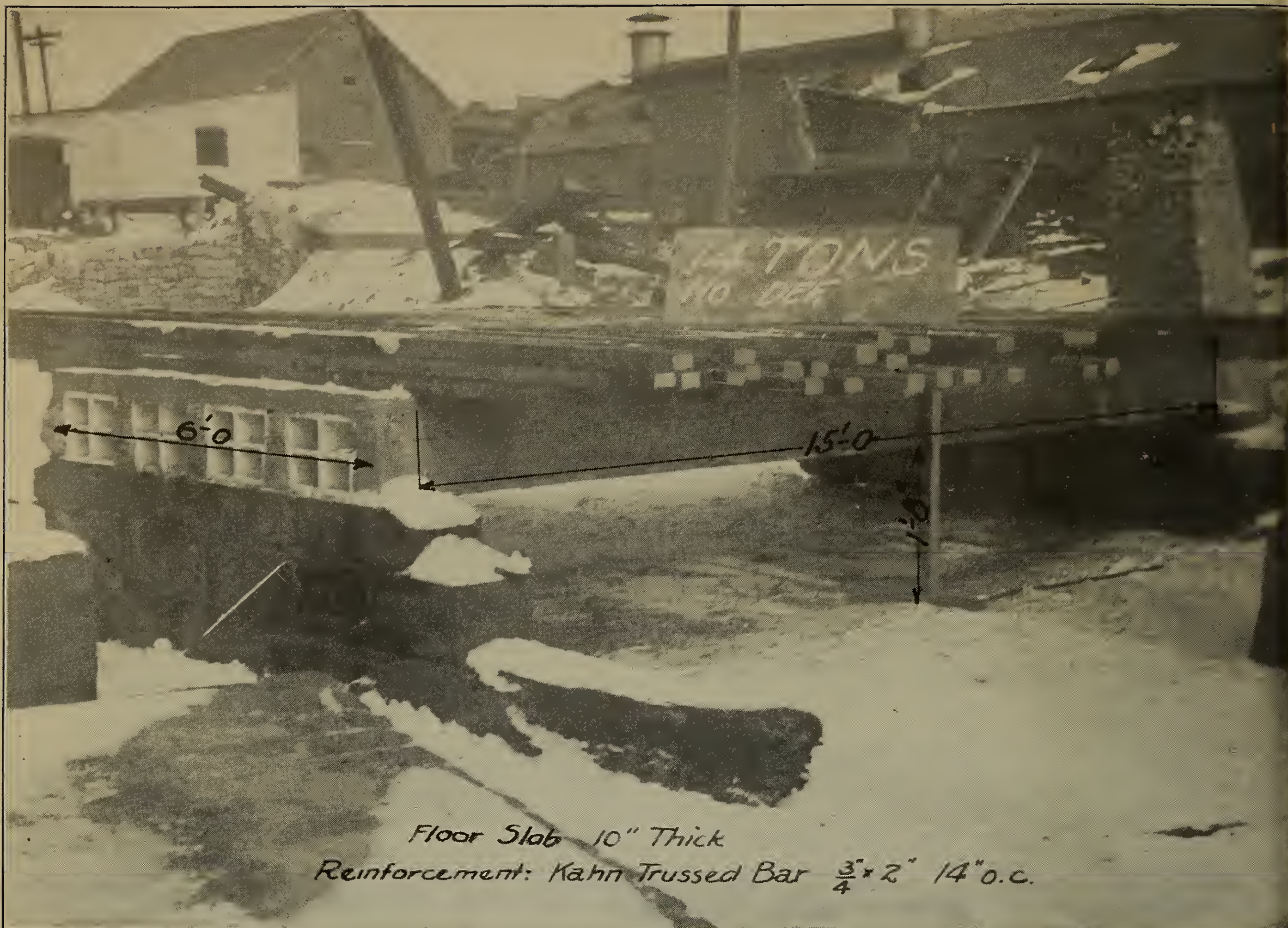

14 TONS
NO DEF
6'-0
15'-0
1'-0
Floor Slab 10" Thick
Reinforcement: Kahn Trussed Bar 3/4 x 2" 14" o.c.

Fig. 31.


CH&DRY
40,000 LBS
3/16" DEF

Fig. 32.

Fig. 33.

Test of Kahn Reinforced Hollow Tile Construction

This floor was constructed in accordance with the Kahn System of Reinforced Hollow Tile Construction. Reinforcement ¾-inch Kahn Trussed Bars, with 8-inch standard diagonals; reinforced concrete beams between tiles, 4x8 inches; dimensions of floor slab given in sketch.

Mixture of concrete, cement, sand, and crushed stone, proportioned 1; 2; 5, mixed by hand and five weeks old.

Floor was loaded with bars of nut iron, 3 inches wide, 2¼ inches thick, 11 feet to 15 feet long; the weight of each bar ranged from 200 to 300 lbs.; each bar was weighed before putting on the slab; the load was uniformly distributed.

The record of the weights and deflections taken were as follows:

12,395 lbs.	No deflection.	36,320 lbs.	1/16 in. deflection.	41,500 lbs.	¼ in. deflection.
27,470 "	" "	37,850 "	⅛ " "	43,130 "	⅜ " "
31,510 "	1/32 in "	40,410 "	3/16 " "		

A small hair-like crack appeared 1½ feet off center of the floor slab when a load of 44,599 pounds was applied. A deflection of ½ inch showed up immediately after.

The deflection gradually increased as the load was applied. At 48,355 pounds a similar crack appeared 1½ feet on the opposite side of the center line. These were the only cracks in evidence until 53,345 pounds were applied.

From this time on, deflections increased more rapidly. Cracks appeared after this at about 4 inch intervals throughout the center of the beam. Each crack would open 3/16 inch to ½ inch, and then another crack would appear. All the cracks were in straight lines and at right angles with the bottom of the slab. All cracks were within the middle five feet of the beams; no cracks whatever were beyond this on either side.

The failure was a slow, gradual failure, after the elastic limit of the steel was surpassed, the steel then stretching in the middle five feet and gradually letting down the beam, until a deflection of 20 inches was reached, its center touching the ground. The dead weight of the floor was 5,400 pounds. The total deflection when loading was stopped, was 20 inches. The concrete did not crush, but opened up at the bottom.

The total live load over 90 sq. ft. of floor slab, was	60,000	pounds.		
Dead weight	5,400	"		
Total in all................................	65,400	"		
Equivalent to a load of........................	730	"	per sq. ft.	
Safe Load	100	"	"	"
Factor of Safety............................	7.3			

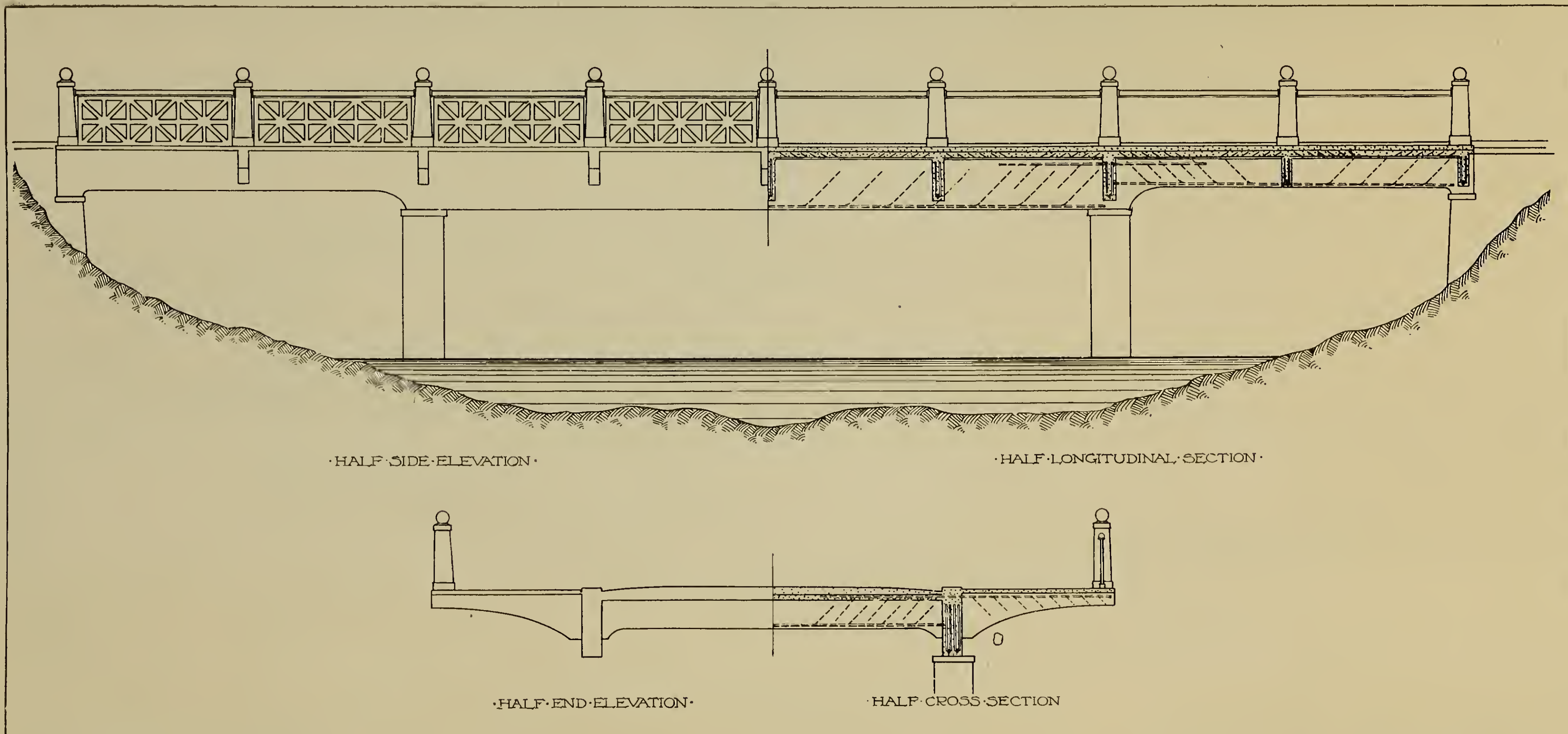


Fig. 35.

Kahn Trussed Bars adapted to Highway Bridges.

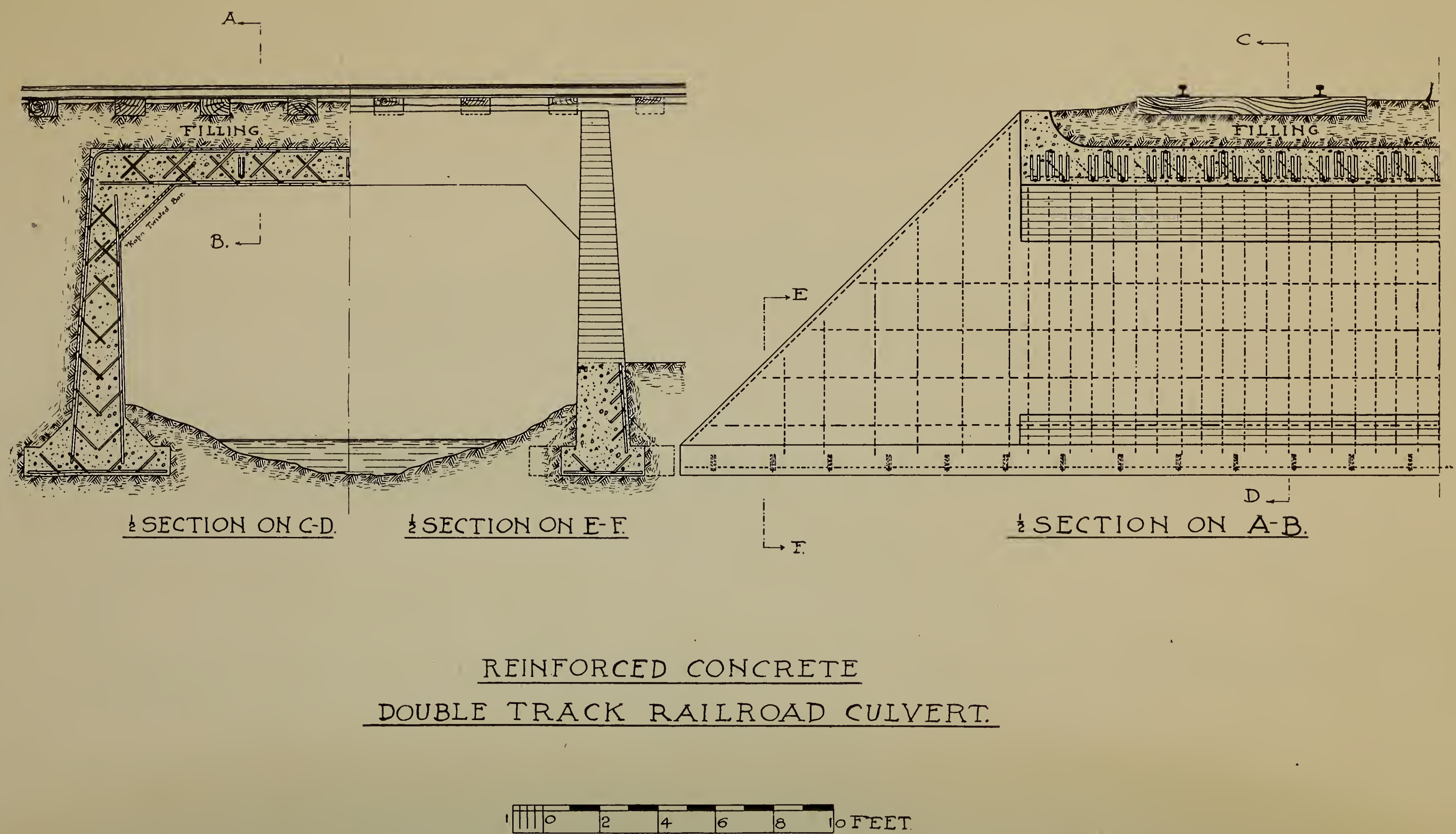
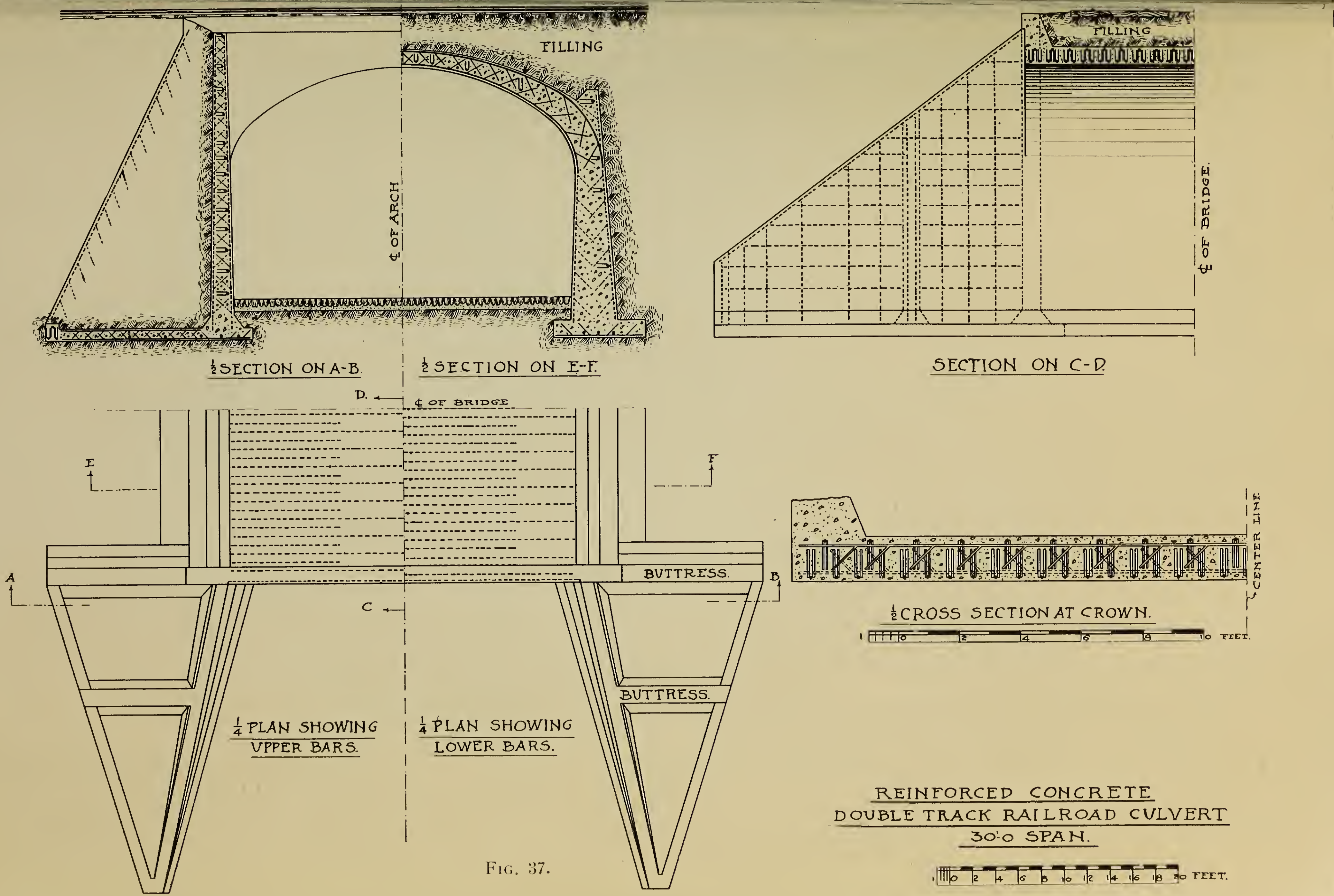

A
B.
C
D
E
F.
FILLING.
FILLING
Kahn Twisted Bar.
½ SECTION ON C-D.
½ SECTION ON E-F.
½ SECTION ON A-B.
REINFORCED CONCRETE
DOUBLE TRACK RAILROAD CULVERT.
0
2
4
6
8
10 FEET

Fig. 36.



FILLING
¢ OF ARCH
½ SECTION ON A-B.
½ SECTION ON E-F.
FILLING
¢ OF BRIDGE
SECTION ON C-D
D.
¢ OF BRIDGE
E
F
A
B
C
BUTTRESS.
BUTTRESS.
¼ PLAN SHOWING UPPER BARS.
¼ PLAN SHOWING LOWER BARS.
CENTER LINE
½ CROSS SECTION AT CROWN.
0 2 4 6 8 10 FEET.
REINFORCED CONCRETE
DOUBLE TRACK RAILROAD CULVERT
30'0 SPAN.
0 2 4 6 8 10 12 14 16 18 20 FEET.

Fig. 37.

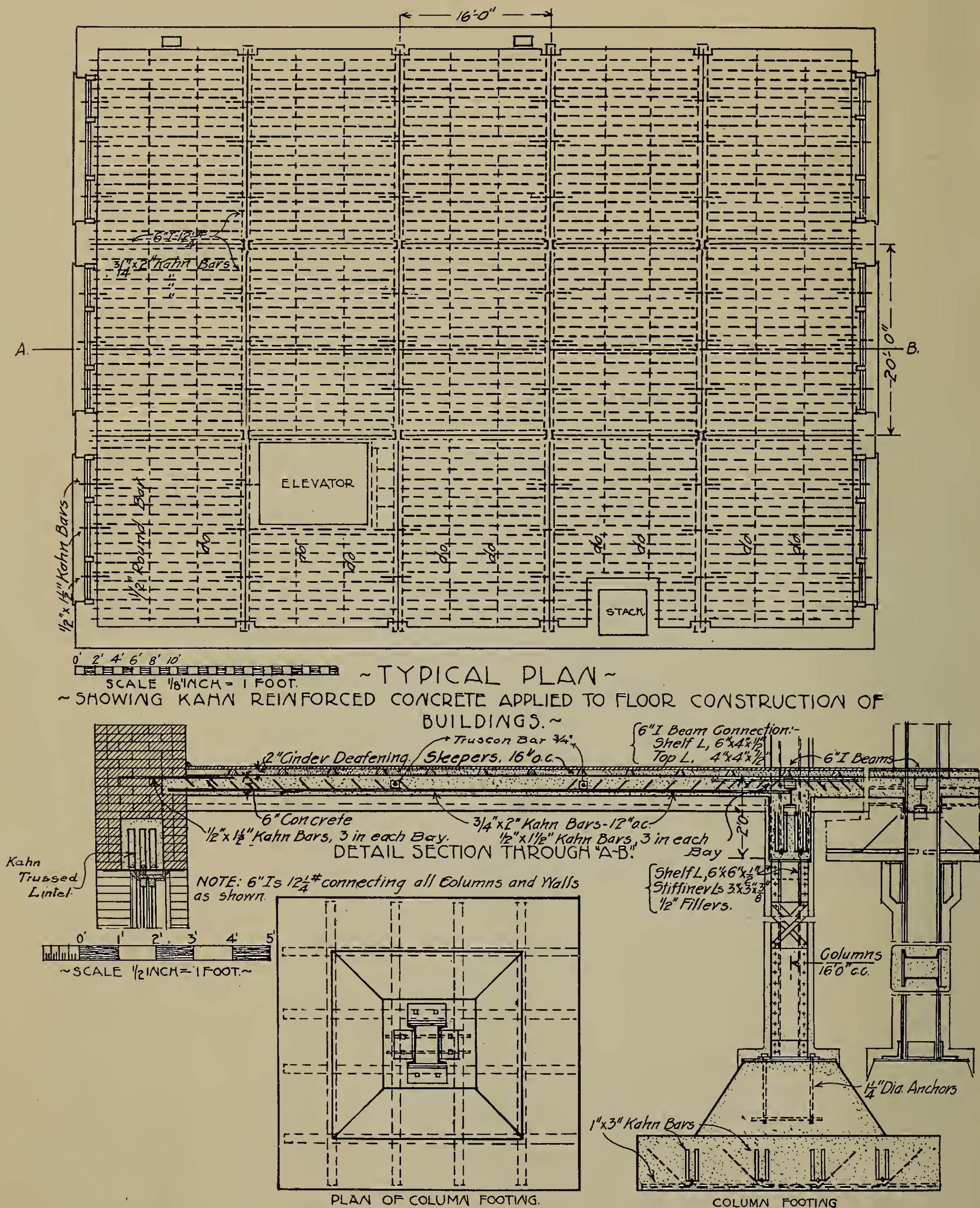

16'-0"
6"I-12¼#
3/4"x2" Kahn Bars
A.
B.
20'-0"
ELEVATOR
STACK
½"x 1½" Kahn Bars
½" Round Bar
SCALE ⅛ INCH = 1 FOOT.
~TYPICAL PLAN~
~SHOWING KAHN REINFORCED CONCRETE APPLIED TO FLOOR CONSTRUCTION OF BUILDINGS.~
Truscon Bar ¾"
2" Cinder Deafening
Sleepers, 16" o.c.
6" I Beam Connection:- Shelf L, 6"x4"x½" Top L, 4"x4"x½"
6" I Beams
6" Concrete
¾"x2" Kahn Bars-12" a.c.
½"x 1½" Kahn Bars, 3 in each Bay.
½"x 1½" Kahn Bars, 3 in each Bay
DETAIL SECTION THROUGH "A-B."
2'0"
Kahn Trussed Lintel
NOTE: 6" Is 12¼# connecting all Columns and Walls as shown.
Shelf L, 6"x6"x½" Stiffener Ls 3"x3"x⅜" ½" Fillers.
~SCALE ½ INCH = 1 FOOT.~
Columns 16'0" c.c.
¾" Dia. Anchors
1"x3" Kahn Bars
PLAN OF COLUMN FOOTING.
COLUMN FOOTING

FIG. 38.

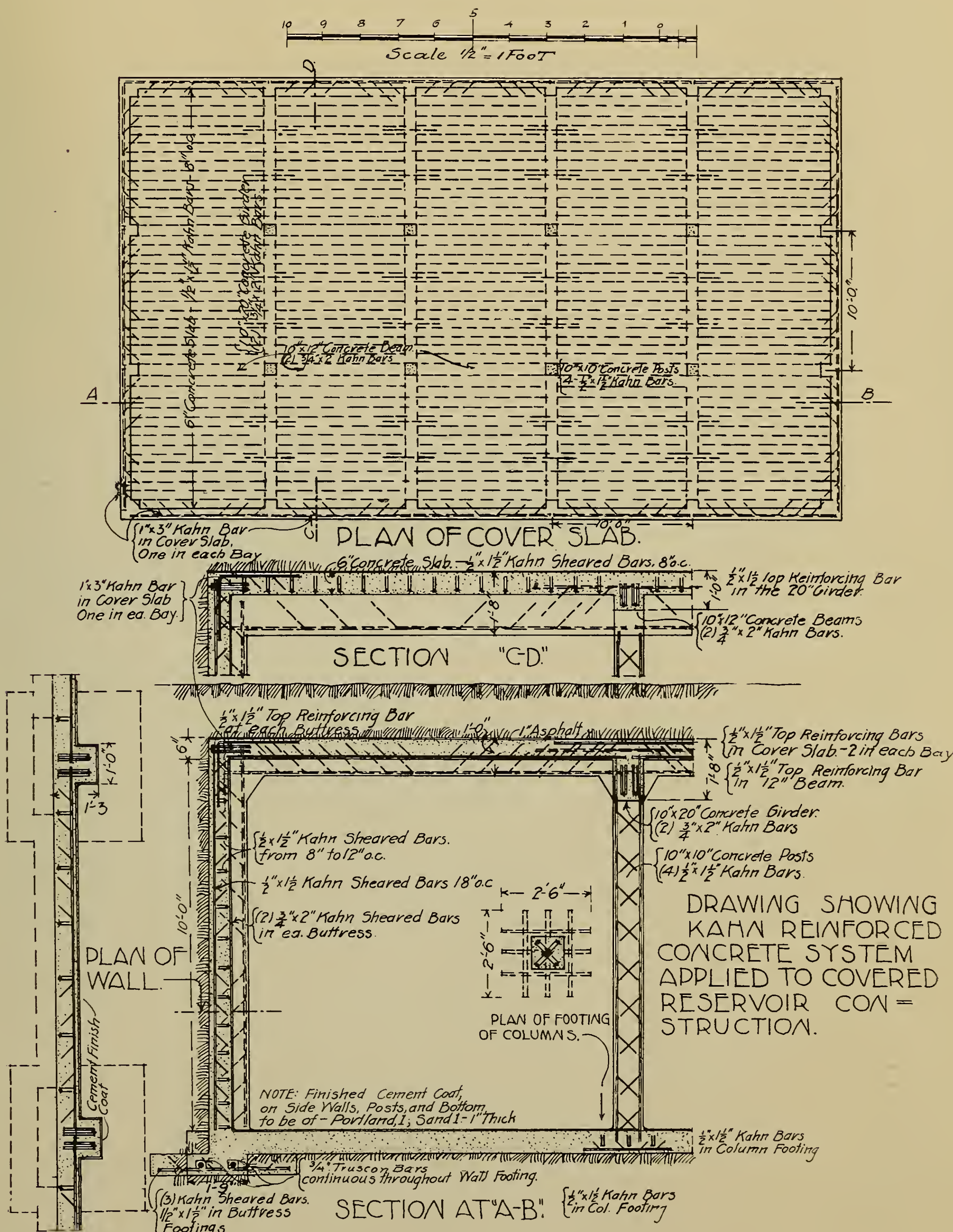

Scale 1/2" = 1 Foot
PLAN OF COVER SLAB.
6" Concrete Slab. 1/2"x1 1/2" Kahn Bars 8" o.c.
10"x12" Concrete Beam
10"x10" Concrete Posts
1"x3" Kahn Bar in Cover Slab, One in each Bay
SECTION "C-D."
6" Concrete Slab. 1/2"x1 1/2" Kahn Sheared Bars, 8" o.c.
1/2"x1 1/2" Top Reinforcing Bar in the 20" Girder.
10"x12" Concrete Beams (2) 3/4"x2" Kahn Bars.
1"x3" Kahn Bar in Cover Slab One in ea. Bay
1/2"x1 1/2" Top Reinforcing Bar at each Buttress
1" Asphalt
1/2"x1 1/2" Top Reinforcing Bars in Cover Slab - 2 in each Bay
1/2"x1 1/2" Top Reinforcing Bar in 12" Beam.
10"x20" Concrete Girder (2) 3/4"x2" Kahn Bars
10"x10" Concrete Posts (4) 1/2"x1 1/2" Kahn Bars.
1/2"x1 1/2" Kahn Sheared Bars. from 8" to 12" o.c.
1/2"x1 1/2" Kahn Sheared Bars 18" o.c.
(2) 3/4"x2" Kahn Sheared Bars in ea. Buttress
PLAN OF WALL.
Cement Finish Coat
PLAN OF FOOTING OF COLUMNS.
DRAWING SHOWING KAHN REINFORCED CONCRETE SYSTEM APPLIED TO COVERED RESERVOIR CONSTRUCTION.
NOTE: Finished Cement Coat, on Side Walls, Posts, and Bottom, to be of - Portland, 1; Sand 1 - 1" Thick
1/2"x1 1/2" Kahn Bars in Column Footing
3/4" Truscon Bars continuous throughout Wall Footing.
(3) Kahn Sheared Bars. 1 1/2"x1 1/2" in Buttress Footings
SECTION AT "A-B."
1/2"x1 1/2" Kahn Bars in Col. Footing

Fig. 39.

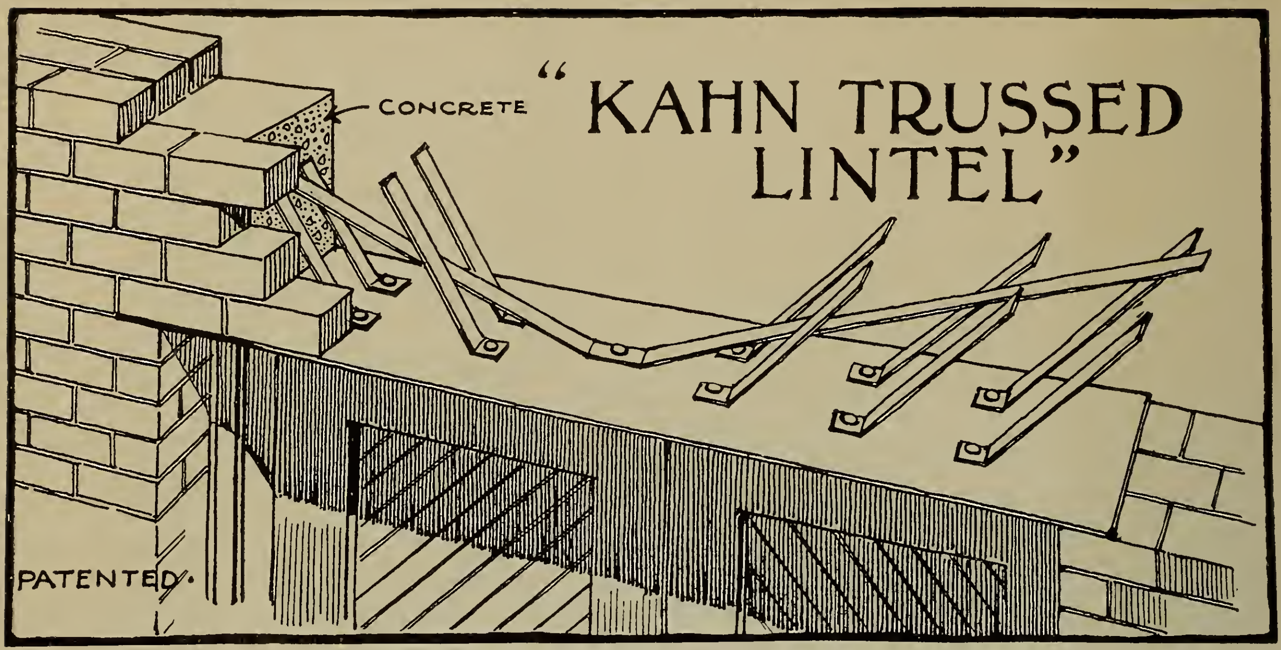


Fig. 40.

Figures 40, 41 and 42 show general views of the Kahn Trussed Lintels. The advantages of a flat headed opening are very great as compared with a segmentally arched opening, and when the brick work above is properly supported, wall cracks are entirely avoided. This type of lintel construction must appeal to the architect at once. No steel beams, channels, or other carrying members whatever, are employed; the very strength of the wall itself is made use of to carry its own weight. Tests which we have made on lintels of this type, have developed strengths greater than steel I beams of the same depth.

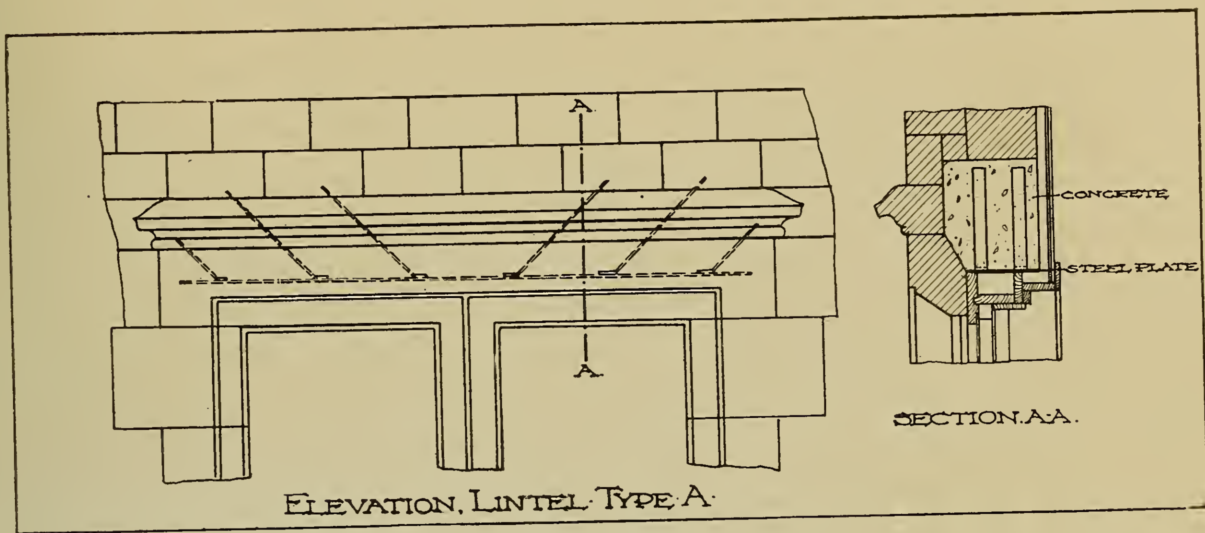

A
A
CONCRETE
STEEL PLATE
SECTION.A-A.
ELEVATION. LINTEL TYPE A

FIG. 41.

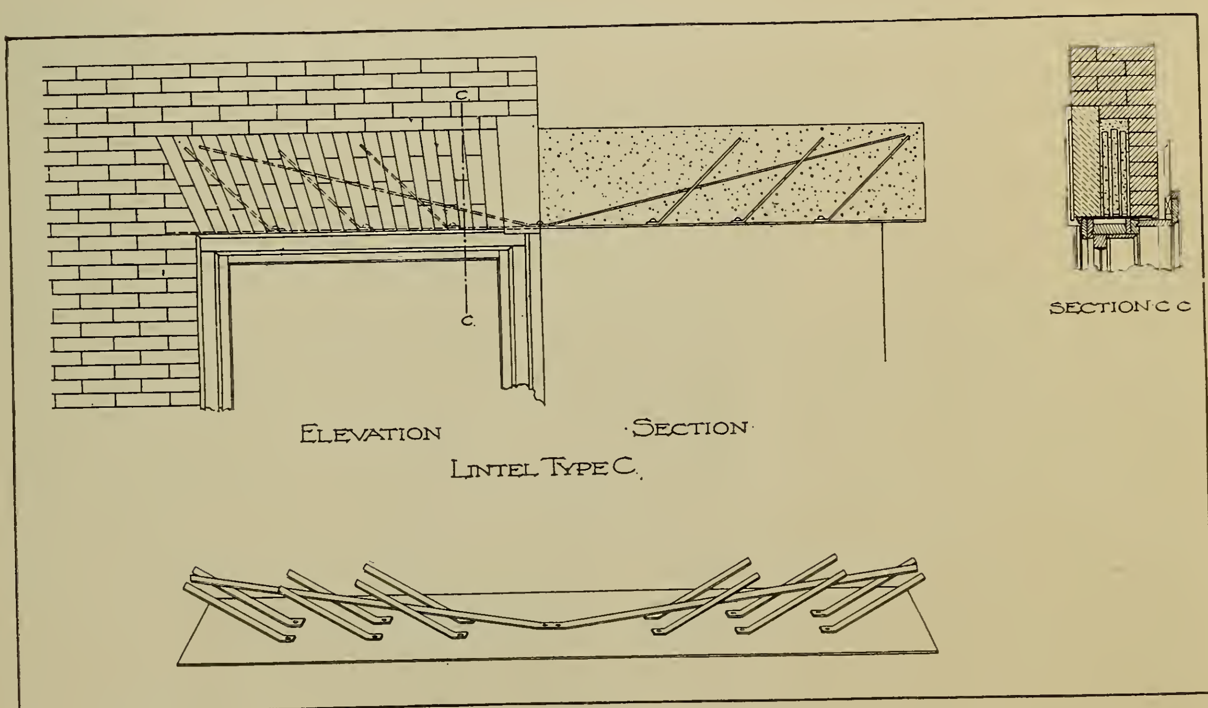

C.
C.
SECTION C C
ELEVATION
SECTION
LINTEL TYPE C.

FIG. 42.

Fig. 43.

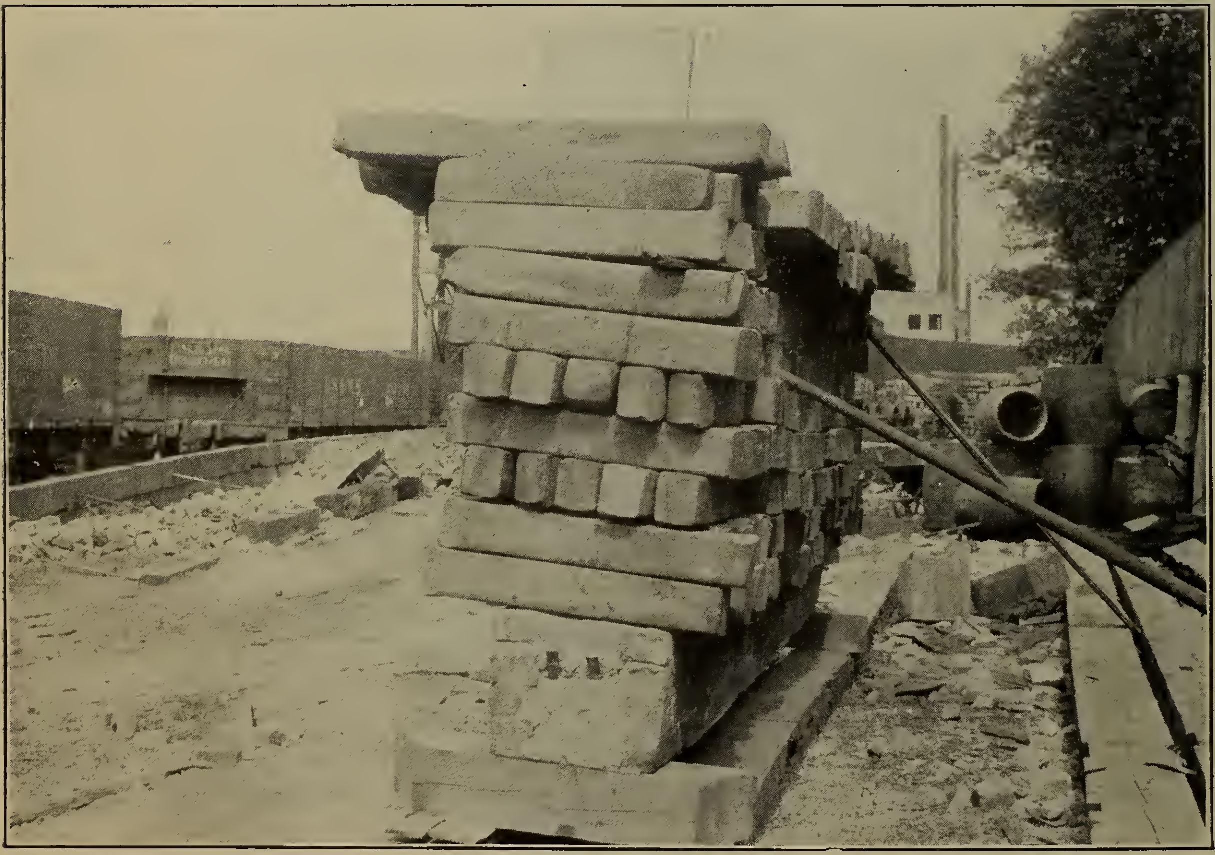


Fig. 44.

Kahn Trussed Lintel, 12 in. deep, 13 in. wide, 12 ft. span.
Load, steel billets, 40720 lbs. Deflection ¼ in.

Fig. 45.

Figures 43, 44 and 45 show some tests which were made on lintels as above described. The load, which is herewith illustrated, is far in excess of that which could possibly come in actual construction, as the tendency of a wall is to arch itself above an opening, and the actual weight which rests upon a lintel is that of a triangle of masonry, forming angles of about 60 degrees with the top of the opening.

The Trussed Concrete Steel Company has always at hand a competent corps of engineers who will be very glad to deal with any special problems which the architect may have at hand, and their services will gladly be given, free of charge, for any construction wherein it is desired to use this type of reinforcement.

Test of Beams Reinforced with Kahn Trussed Bars

FIG. 46.

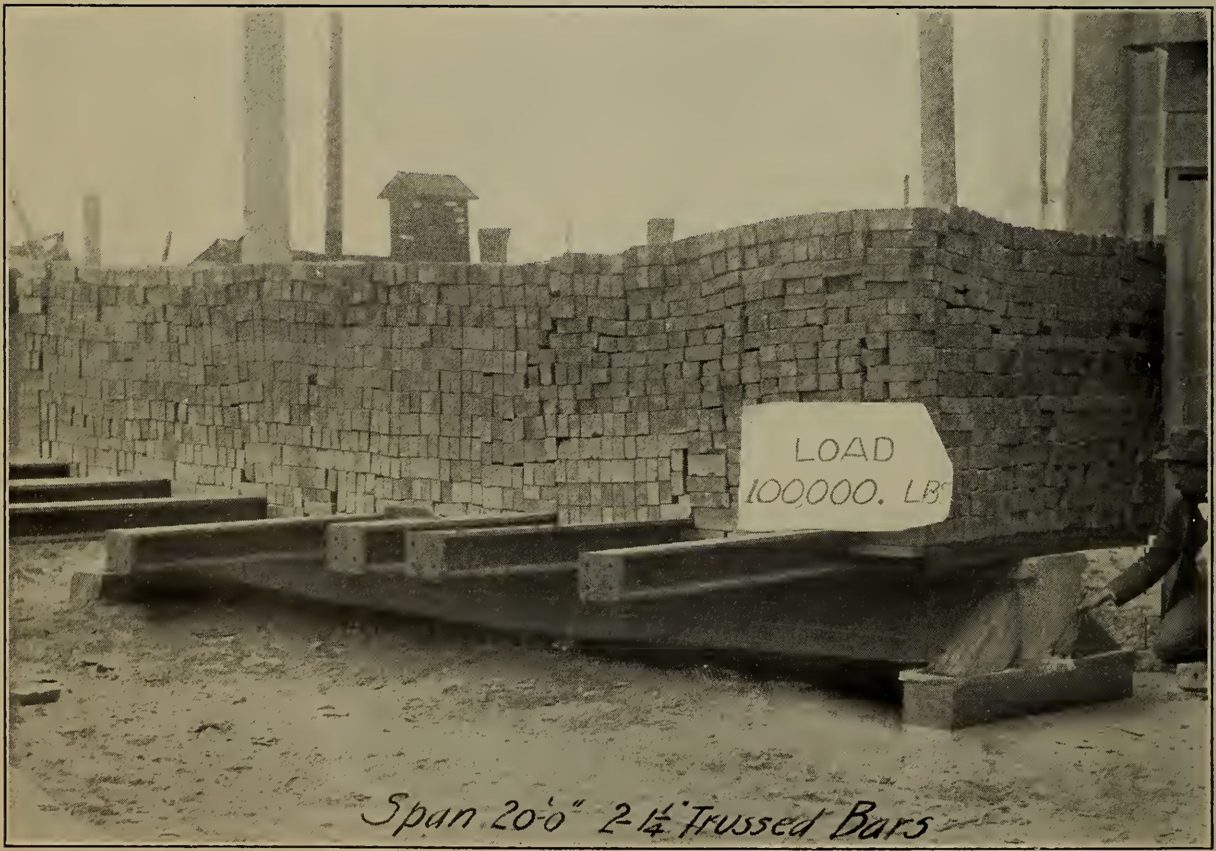


FIG. 47.
Depth of beam=20″.

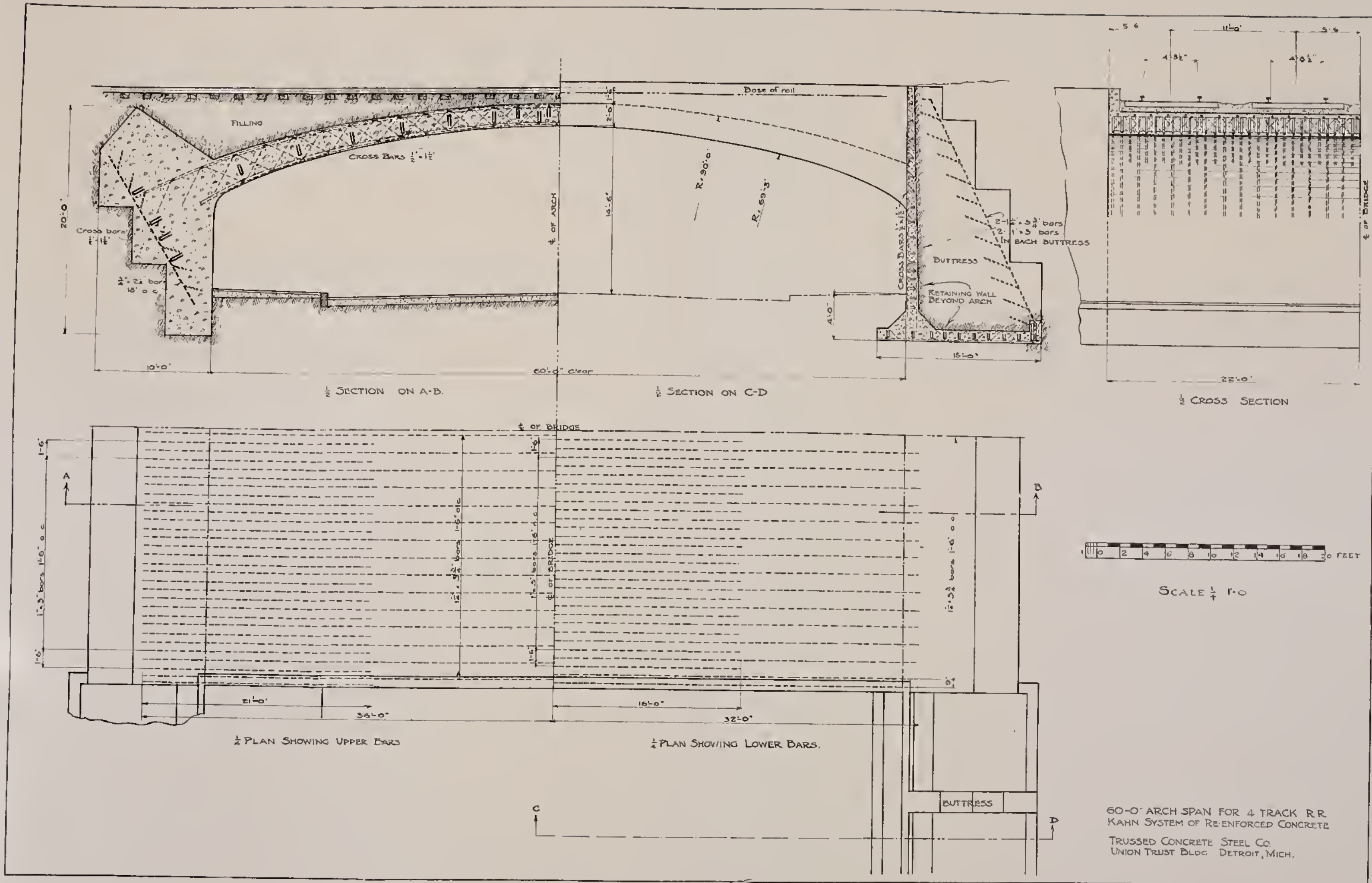
Amounts of Cement, Sand and Stone required for concrete mixtures of various proportions

Concrete with 2½ inch Stone						Concrete with Gravel ¾ inch and under					
Proportons of Mixture			Required for 1 cubic yard			Proportions of Mixture			Required for 1 cubic yard		
Cement	Sand	Stone	Cement, Bbls.	Sand, c. yds.	Stone, c. yds.	Cement	Sand	Gravel	Cement, Bbls.	Sand, c. yds.	Gravel, c. yds.
1	1	2 0	2.72	0.41	0.83	1	1	2.5	2.10	0.32	0.80
1	1	2.5	2.41	0.37	0.92	1	1	3.0	1.89	0.29	0.86
1	1	3.0	2.16	0.33	0.98	1	1	3.5	1.71	0.26	0.91
						1	1	4.0	1.55	0.24	0.94
1	1.5	2.5	2.16	0.49	0.82	1	1.5	3.0	1.71	0.39	0.78
1	1.5	3.0	1.96	0.45	0.89	1	1.5	3.5	1.57	0.36	0.83
1	1.5	3.5	1.79	0.41	0.96	1	1.5	4.0	1.46	0.33	0.88
1	1.5	4.0	1.64	0.38	1.00	1	1.5	4.5	1.34	0.31	0.91
						1	1.5	5.0	1.24	0.28	0.94
1	2.0	3.0	1.78	0.54	0.81	1	2.0	3.5	1.44	0.44	0.77
1	2.0	3.5	1.66	0.50	0.88	1	2 0	4.0	1.34	0.41	0.81
1	2.0	4.0	1.53	0.47	0.93	1	2.0	4.5	1.26	0.38	0.86
1	2.0	4.5	1.43	0.43	0.98	1	2.0	5.0	1.17	0.36	0.89
						1	2.0	6.0	1.03	0.31	0.94
1	2.5	3.5	1.51	0.58	0.81	1	2.5	4.0	1.24	0.47	0.75
1	2.5	4.0	1.42	0.54	0.87	1	2.5	4.5	1.16	0.44	0.80
1	2.5	4.5	1.33	0.51	0.91	1	2.5	5.0	1.10	0.42	0.83
1	2.5	5.0	1.26	0.48	0.96	1	2.5	5.5	1.03	0.39	0.86
1	2.5	5.5	1.18	0.44	0.99	1	2 5	6.0	0.98	0.37	0.89
						1	2.5	7.0	0.88	0.33	0.93
1	3.0	4.0	1.32	0.60	0.80	1	3.0	5.0	1.03	0.47	0.78
1	3.0	4.5	1.24	0.57	0.85	1	3.0	5.5	0.97	0.44	0.81
1	3.0	5.0	1.17	0.54	0.89	1	3.0	6.0	0.92	0.42	0.84
1	3.0	5.5	1.11	0.51	0.93	1	3.0	6.5	0.88	0.40	0.87
1	3.0	6.0	1.06	0.48	0.97	1	3.0	7.0	0.84	0.38	0.89
						1	3.0	7.5	0.80	0.37	0.91
						1	3.0	8.0	0.76	0.35	0.93
1	3.5	5.0	1.11	0.59	0.85	1	3.5	6.0	0.88	0.46	0.80
1	3.5	5.5	1.06	0.56	0.89	1	3.5	6.5	0.83	0.44	0.82
1	3.5	6.0	1.00	0.53	0.92	1	3.5	7.0	0.80	0.43	0.85
1	3.5	6.5	0.96	0.51	0.95	1	3.5	7.5	0.76	0.41	0.87
1	3.5	7.0	0.91	0.49	0.98	1	3.5	8.0	0 73	0.39	0.89
						1	3.5	8.5	0.71	0.38	0.91
						1	3.5	9.0	0.68	0.36	0.92
1	4.5	6.0	0.95	0.58	0.87	1	4.0	7.0	0.77	0.47	0.81
1	5.0	6.5	0.91	0.55	0.90	1	4.0	7.5	0.73	0.44	0.83
1	4.0	7.0	0.87	0.53	0.93	1	4.0	8.0	0.71	0.43	0.86
1	4.0	7.5	0.84	0.51	0.96	1	4.0	8.5	0.68	0.42	0.88
1	4.0	8.0	0.81	0.49	0.98	1	4.0	9.0	0.65	0.40	0.89
						1	4.0	9.5	0.63	0.38	0.91
						1	4.0	10.0	0.61	0.37	0.93
1	5.5	8.0	0.74	0.57	0.91	1	5.0	10.0	0.57	0.43	0.87
1	5.0	9.0	0.70	0.53	0.96	1	5.0	12.0	0.51	0.38	0.92
1	6.0	9.0	0.65	0.59	0.89	1	6.0	12.0	0.48	0.44	0.88
1	6.0	10.0	0.62	0.56	0.93	1	6.0	14.0	0.43	0.40	0.92
1	7.0	11.0	0.54	0.51	0.91	1	7.0	14.0	0.42	0.44	0.88
1	7.0	12.0	0.52	0.55	0.95	1	7.0	16.0	0.38	0.40	0.92

ORDER BLANK

No. of Pieces	Size	Weight	Length of Bars	No. Diagonals on each end	Length of Diagonals

These blanks furnished on application



½ SECTION ON A-B.
½ SECTION ON C-D
½ CROSS SECTION
½ PLAN SHOWING UPPER BARS
½ PLAN SHOWING LOWER BARS.
SCALE ¼ 1'-0
60-0" ARCH SPAN FOR 4 TRACK R.R.
KAHN SYSTEM OF RE-ENFORCED CONCRETE
TRUSSED CONCRETE STEEL CO.
UNION TRUST BLDG. DETROIT, MICH.

Fig. 48.